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## CHEMICAL OBSERVATIONS OF SOME INDIAN PLANT DRUGS

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IN the course of a programme of work on the extraction and separation of components of Indian plant drugs for pharmacological and clinical experiments the following three plants have been examined by us.\*

*Mimusops elengi* (N.O. Sapotaceae) is an evergreen tree growing wild and also cultivated in gardens in various parts of India. Its bark is the most important and is used as a febrifuge, tonic and astringent and its decoction is considered beneficial in diseases of the gums and teeth.

The stem-bark collected from the Delhi University Campus was extracted with petroleum ether (60–80°), ether and alcohol in succession. The petroleum ether extract on removal of the solvent gave an oily residue; T.L.C. (silicagel; chloroform: benzene 1:1) indicated the presence of two major components A and B. Their separation could be followed by fractional crystallisations and re-chromatography.

Compound A (80 mg per kg) separated as colourless plates from acetone, m.p. 164°. It answered Liebermann-Burchard and Salkowski's tests. The presence of unsaturation was indicated by the I.R. spectrum and tetranitromethane test. On treatment with acetic anhydride-pyridine (room temperature; 24 hr.) a monoacetate was obtained, m.p. 178°. The compound and its acetate gave green colouration with bromine in chloroform (Tortelli-Jaffe test). All these properties agree with those of  $\alpha$ -spinasterol. The identity was established by direct comparison with an authentic sample.

Compound B (100 mg per kg) crystallised from acetone as colourless needles, m.p. 274–75°, and answered tests for triterpenoids. The I.R. spectrum indicated the presence of hydroxyl and unsaturation. Acetylation gave a monoacetate, m.p. 304° which on treatment with hydrochloric-acetic acid mixture isomerised to a product, which was identified as  $\beta$  amyirin acetate. A comparison of the properties of compound B with those of naturally occurring monohydroxy triterpenes indicated that it could

be taraxerol. A direct comparison, m.m.p., TLC of B and its acetate with taraxerol and its acetate confirmed the identity.

The ether extract of the bark left a dark sticky mass which when washed with a little ethanol turned into definite powder of less colour. It was chromatographed on alumina when some more of  $\alpha$ -spinasterol and taraxerol were obtained.

The alcohol extract of the bark on concentration yielded a large amount of dark red semi-solid. It was largely extractable with water leaving behind a little amorphous impurity; the aqueous extract was extracted with *n*-butanol. The *n*-butanol concentrate was poured into ether when a brown amorphous solid (about 5% yield) was obtained. This gave tests for leucoanthocyanidin polymer and no definite compound could be isolated.

The occurrence of spinasterol and taraxerol has been recently reported also in brief by Misra and Mitra.<sup>1</sup>

**Wood.**—The petroleum ether and ether extract of the heartwood contained the same components as the bark. The alcohol extract contained a colourless compound which was identified as meso-inositol (200 gm per kg). These extracts appear to be free from tannins.

**Leaves.**—Fresh leaves of *M. elengi* were extracted with alcohol and the alcohol extract fractionated into water-soluble and water-insoluble parts. The insoluble part which contained chlorophyll and waxes, on chromatography over alumina gave taraxerol (20 mg from 500 g). The aqueous solution contained a flavonoid glycoside not extracted by ether and on hydrolysis with aqueous sulphuric acid gave quercetin identified by colour reactions and chromatography.

**Flowers.**—The alcohol extract of the flowers was fractionated into ether-soluble and ether-insoluble part. The former gave positive test for triterpenoids; T.L.C. showed that it was a complex mixture. The ether-insoluble part on hydrolysis gave quercetin indicating that it contained a quercetin glycoside.

*Ricinus communis* (Eranda) root-bark has been used in Ayurvedic medicine in the treatment of nervous diseases, sciatica and rheumatism. The air-dried root-bark samples collected from one-year old plants after harvest of seeds from three

\* An account was given at the special symposium during the Science Congress Session at Hyderabad, January 1967. See Abstracts D-29, Indian Science Congress, Hyderabad, 1967.

different localities, Delhi, Hardwar and Hyderabad were examined separately and gave the same results. The powdered bark was extracted with petroleum ether (60–80°), benzene, ether acetone and alcohol in succession. The petroleum ether extract on column chromatography over alumina gave a crystalline solid (120 mg per 360 g) m.p. 159°,  $[\alpha]_D + 66$  (C 7.88 mg ml in  $CHCl_3$ ), which gave a positive Liebermann-Burchard test and a positive Salkowski's test; tetranitromethane test was also positive. With acetic anhydride and pyridine in the cold it gave an acetate, m.p. 136–38°, it also formed a benzoate, m.p. 147°; UV spectrum of the compound was similar in shape to that of authentic ergosterol (*viz.*, 261, 272, 282, 294 m $\mu$ ). However, absorption intensity of this compound was much lower than that of ergosterol. The acetate of the compound also showed a similar type of diene absorption (272, 283, 295 m $\mu$ ). The Tortelli-Jaffe's test (Br<sub>2</sub> in chloroform) was negative. Due to paucity of the material and low yield of this compound detailed structural investigation could not be carried out.

The benzene and ether extracts of the root bark were very small in amounts and could not be studied. The acetone extract (10 g per 360 g) and alcohol extract (35 g per 360 g) were very similar in nature and were mixed, dried in the vacuum desiccator and extracted with absolute alcohol. The alcohol-insoluble part showed the presence of inorganic ions  $K^+$ ,  $Na^+$ ,  $Mg^{++}$ ,  $Cl^-$  and  $NO_3^-$ . The alcohol-soluble portion gave a blue ferric reaction. Attempts to obtain a crystalline component by lead salt procedure followed by crystallisation and column chromatography were unsuccessful. Hydrolysis of alcoholic extract with 7% aqueous sulphuric acid yielded gallic acid and glucose

which were not present in the extract before hydrolysis. Gallotannins therefore constituted considerable portions of the above extracts besides mineral matter.

The aqueous extract of the root bark showed the presence of  $Fe^{+++}$ ,  $Al^{+++}$ ,  $Mn^{++}$ ,  $Ca^{++}$ ,  $Mg^{++}$ ,  $K^+$ ,  $Na^+$ ,  $CO_3^{--}$ ,  $NO_3^-$ ,  $Cl^-$ ,  $SO_4^{--}$  and  $PO_4^{--}$  ions.  $Ca^{++}$  and  $Mg^{++}$  were the major constituents.

*Pluchea lanceolata* (Rasna) is another plant with uses similar to those of *R. communis*. The air-dried leaves of the plant were used. The petroleum ether extract on chromatography over alumina gave a crystalline solid (1 g/kg), m.p. 237–40°, which gave a positive Liebermann-Burchard test. Spectral data of the compound indicated the presence of acetoxyl and unsaturation. It could be hydrolysed by 20% aqueous sodium hydroxide solution to the hydroxy compound, m.p. 218°. Subsequent alcoholic extract on concentration deposited inorganic matter which was separated. Purification of the extract by precipitation as lead salt gave a yellow solid which was found to be a mixture of two compounds by TLC. The two compounds were separated by column chromatography over silica gel and were identified as quercetin and isorhamnetin by colour reactions, UV, and visible spectra with the usual shifts with reagents and preparation of their acetates and methyl ethers. The identity was confirmed by direct comparison with authentic samples of quercetin and isorhamnetin. The flavonoids were present as aglycones in a yield of 700 mg/kg and no glycosides were detected.

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I. Misra, G. and Mitra, C. R., *Phytochemistry*, 1967 6, 1308.

## ON THE SPIN OF THE 413 keV STATE IN $Pm^{147}$

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THE decay scheme of  $Nd^{147}$  to  $Pm^{147}$  is well studied.<sup>1-5</sup> The spins of the excited states are determined mainly from angular correlation studies. The characters of the ground and the 91 keV states are established to be  $7/2^+$  and  $5/2^+$  respectively. The spin assignment for the 413 keV state, however, is still uncertain, the values of  $3/2$ ,  $5/2$  or  $7/2$  being favoured by different workers.<sup>4-8</sup> A reinvestigation is therefore made employing a sum coincidence

method which has several advantages over the conventional angular correlation techniques so far used.

The main features of the decay scheme  $Nd^{147} \rightarrow Pm^{147}$  are shown in Fig. 1. The experimental arrangement employed is a conventional fast-slow sum-coincidence system with a 100 channel analyser and is described elsewhere.<sup>9</sup> The sum coincidence spectrum obtained with gate at 413 keV is shown in Fig. 2. It clearly

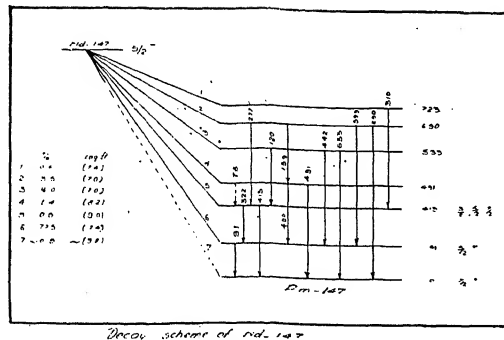


FIG. 1. Decay scheme of Nd-147.

shows peaks at 91 and 322 keV. The experiment is conducted by recording the sum coincidence spectra under same conditions for angles  $180^\circ$ ,  $135^\circ$  and  $90^\circ$  between the detectors. At each angle a pooled total of 10,000 counts under the peaks are collected and they are fitted to a polynomial of the type

$$W(\theta) = 1 + A_2 P_2(\cos \theta) + A_4 P_4(\cos \theta)$$

after correcting the count rates for the sum coincidences and wrong gate setting contributions employing White's method.<sup>10</sup> The correlation coefficients are corrected for finite detector sizes employing the experimentally determined values of attenuation coefficients in a manner

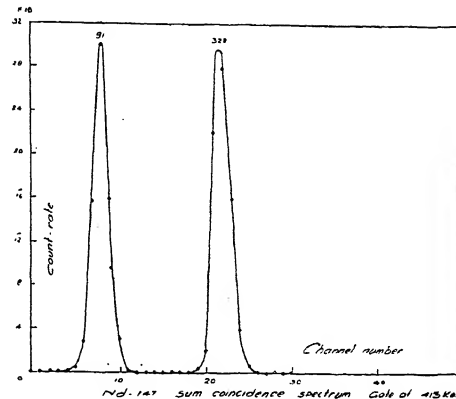


FIG. 2. Nd-147 sum coincidence spectrum. Gate at 413 keV.

An examination of Table I shows that none of the theoretical values shows any agreement both in magnitude and sign with the present experimental value. However, if due allowance is made for the errors in the mixing ratios, the value of  $A_2$  obtained, assuming a spin of  $3/2$  for the 413 keV and like phases for both transitions ( $\delta$ -positive), agrees with the present experimental value. The present experiment therefore favours an assignment of  $3/2$  for the spin of the 413 keV state in  $Pm^{147}$ .

TABLE I  
Theoretical values of  $A_2$  for the  $322 \rightarrow 91$  keV gamma-gamma correlation

Spin sequence $\rightarrow$	$3/2 \rightarrow 5/2 \rightarrow 7/2$	$5/2 \rightarrow 5/2 \rightarrow 7/2$	$7/2 \rightarrow 5/2 \rightarrow 7/2$
$\delta_1$ Positive	-0.147	-0.209	+0.087
$\delta_2$ "			
$\delta_1$ Negative	-0.024	-0.002	+0.001
$\delta_2$ "			
$\delta_1$ Positive	+0.012	+0.017	-0.007
$\delta_2$ Negative			
$\delta_1$ "	+0.301	+0.029	-0.007
$\delta_2$ Positive			

$\delta_1$  and  $\delta_2$  refer to the mixing amplitudes in 322 keV and 91 keV gamma-rays.

described by Frankel.<sup>11</sup> The corrected values of the correlation coefficients are

$$A_2 = -0.075 \pm 0.013 \text{ and } A_4 = -0.010 \pm 0.013.$$

Accepting the spins of the ground and the 91 keV states to be  $7/2^+$  and  $5/2^+$  and assuming the mixing ratios of the 91 and 322 keV transitions

$$(91 \text{ keV} : 99.2\% \text{ M1} + 0.8\% \text{ E2 and}$$

$$322 \text{ keV} : 80\% \text{ M1} + 20\% \text{ E2})$$

from the data of Ewan *et al.*,<sup>12</sup> theoretical values of  $A_2$  and  $A_4$  are estimated for each spin assignment  $3/2$ ,  $5/2$  and  $7/2$  for the 413 keV state and for both signs of the mixing ratio ( $\delta$  positive as well as negative). The resulting values of  $A_2$  are given in Table I. The values of  $A_4$  are vanishingly small in all cases.

1. Rajput, M. S. and Sehgal, M. L., *Ind. J. Phys.*, 1967, **41**, 176.
2. Sastry, V. V. G., Lakshminarayana, V. and Swami Jnanananda, *Ind. J. Pure & Appl. Phys.*, 1964, **2**, 307.
3. Hosen *et al.*, *Acta Phys. Sinica*, 1964, **20**, 383.
4. Spring, E., *Phys. Lett.*, 1963, **7**, 218.
5. Gunye, M. R., Jambunathan, R. and Saraf, B., *Phys. Rev.*, 1961, **124**, 178.
6. Westernberger, G. A. and Shirley, D. A., *Ibid.*, 1961, **123**, 1812.
7. Arya, A. P., *Ibid.*, 1961, **122**, 1226.
8. Bodendstedt, E., *et al.*, *Z. Phys.*, 1960, **160**, 33.
9. Ranakumar, N., *Ph.D. Thesis*, Andhra University, 1966.
10. White, D. M., *Nuc. Inst. & Meth.*, 1963, **21**, 209.
11. Frankel, S., *Phys. Rev.*, 1951, **83**, 673.
12. Ewan, G. T., Graham, R. L. and Geiger, J. S., *Bull. Amer. Phys. Soc.*, 1961, **6**, 238.

## A PRELIMINARY REPORT ON THE BREEDING SITES AND INCIDENCE OF *Aedes* IN DELHI

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THE yellow fever mosquito, *Aedes aegypti*, has been shown to be the main potential vector of hæmorrhagic fever in India.<sup>1</sup> In view of the recent outbreak of hæmorrhagic fever / chikungunya fever in Calcutta in 1963<sup>2</sup> and again in Madras and Pondicherry in 1964<sup>3</sup>, the control of this tropicopolitan mosquito is of paramount importance to India. A thorough study of the bionomics of the vector mosquitoes is essential for a proper assessment of the epidemic potentiality of this disease in other parts of India. On the basis of a survey undertaken in September 1964 Krishnamurthy *et al.*<sup>4</sup> have reported a high incidence of *A. aegypti* in Delhi area. An unusually large increase of mosquitoes in Delhi in October–November 1967 coupled with a high incidence of a febrile illness similar to hæmorrhagic fever, presumably mosquito-borne (the exact nature of the fever and its transmission are under investigations elsewhere), has necessitated a further study on the relative abundance of the various species of *Aedes*. This preliminary report deals with the larval habitat of various species of *Aedes* in Delhi based on a survey conducted during September–October 1967 as a part of the study programme of insecticide resistance in Indian strains of this mosquito.

Fifteen different localities within the metropolitan Delhi (Table I) were chosen during the period September 8 to October 11, 1967 and a limited survey was carried out with reference to the breeding sites where mosquito larvæ could be collected. Many types of containers holding water within the precincts of waste lands, gardens, houses and shops were examined. The larvæ collected from these sites were allowed to pupate in the laboratory and the emerging adults were scored for the various species. A certain number of larvæ were used to assess their susceptibility to DDT using WHO standard test kit.

The mean atmospheric temperature in Delhi during the survey period ranged from 21.6° C. to 32.3° C. The total rainfall for the period July–September was 887.9 mm., much higher than in previous years and the mean relative humidity was as high as 80%. The climatic

factors during this period were congenial for profuse breeding of mosquitoes and the rain water accumulated in various containers proved to be good breeding ground.

TABLE I  
*Results of larvæ collections of Aedes from  
fifteen areas in metropolitan Delhi*

Area	No. of containers examined	No. of containers positive for <i>Aedes</i>	Total no. of <i>Aedes</i> larvæ	No. of <i>A. aegypti</i>	No. of <i>A. albopictus</i>	No. of <i>A. vittatus</i>
University campus	24	24	362	30	140	192
Kamala Nagar	16	3	44	..	38	6
Roop Nagar	6	3	345	150	173	22
Karol Bagh	67	67	350	350	..	..
Red Fort	2	..	..	..	..	..
Kingsway Camp	13	13	147	..	147	..
Model Town	14	..	..	..	..	..
Mazlis Park	14	..	..	..	..	..
Adarsh Nagar	21	..	..	..	..	..
Indra Nagar	1	..	..	..	..	..
Rajouri Garden	14	6	43	45	..	..
Ansari Nagar	23	14	525	..	525	..
Palam Cononment	49	..	..	..	..	..
Birla Mandir	11	6	50	50	..	..
Anand Parbhat	26	2	145	145	..	..
Total	301	138	2013	770	1023	220

The results of the present survey are given in Table I. Out of a total of 301 containers examined 138 were positive for *Aedes* larvæ, their gross breeding index being as high as 45.8. The remaining 163 containers showed a large number of mosquito larvæ belonging to various species of *Anopheles* and *Culex*. In few instances all the three types of larvæ were found together. Among the *Aedes* collected 50.5% constituted *A. albopictus*, 38.3% *A. aegypti* and 19.9% *A. vittatus*.

The breeding sites of these three species varied to a certain extent. *A. aegypti* was found breeding close to human habitations particularly more in densely populated areas such as Karol Bagh. It was collected mostly from containers like unused motor tyres, broken pots and drums. A few larvæ could also be collected from a blocked nullah with clear water. The other

two species are comparatively wild species and were found to breed in areas away from houses such as gardens and waste lands. All the species of *Aedes* are observed to breed in receptacles containing either rain-water or stored tap-water. *A. albopictus* was found to breed mostly in dirty water while *A. vittatus* preferred breeding in flower pots with hydrophytes and in cemented water tanks maintained in gardens. Other mosquitoes like *Culex* appeared to prefer more stagnant and polluted waters whereas *Anopheles* was observed to be breeding in dirty still waters and in temporary rain-water puddles along shallow ditches on the roadside.

The present survey, though it did not cover the entire metropolitan Delhi, indicates the prevalence of all the three species of *Aedes* due to the easy availability of breeding sites in the area surveyed. The results also show a spread in the breeding foci of *A. aegypti* and *A. albopictus* from the premises already reported in 1964 survey.<sup>4</sup> This spreading was probably due to the highly favourable climatic factors prevalent during July–October 1967. The successful transmission of Calcutta strain of chikungunya virus in the laboratory through *A. aegypti* and *A. albopictus* suggest their

importance as potential vectors.<sup>1</sup> The high anthropophilic index for *A. aegypti*<sup>4</sup> indicates its high epidemic potential. The potential role of *A. albopictus* must also be taken into consideration because of its increased occurrence and present distribution in Delhi. The anthropophilic index of this species needs investigation. Preliminary experiment on DDT tolerance conducted on the larvae collected from various places shows their LC<sub>50</sub> to DDT varied from 0.011 ppm to 0.065 ppm which shows that they are not yet tolerant to this insecticide in this area. However, *A. aegypti* is known to develop resistance to insecticides and also have the ability to change their breeding sites due to their high genetic plasticity. Thus, any control programme planned using DDT as the insecticide should be intensive and without delay.

We wish to thank Professor B. R. Seshachar for his encouragement. This project is financed by WHO Medical Research Grant No. R/00143.

1. Ramachandra Rao, T., Singh, K. R. P. and Pavri, K. M., *Curr. Sci.*, 1964, **33**, 235.
2. Wattal, B. L., *Ind. Jour. Med. Res.*, 1964, **52**, 710.
3. Reuben, R., *Ibid.*, 1967, **55**, 1.
4. Krishnamurthy, B. S., Kalra, N. L., Joshi, G. C. and Singh, N. N., *Bull. Ind. Soc. Mal. Com. Dis.*, 1965, **2**, 56.

## ARTIFICIAL AND NATURAL POLYPLOIDS IN *ANTIRRHINUM*

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**A**NTIRRHINUM is well known for its lack of natural polyploidy,<sup>1</sup> but data obtained by us and Gunther and Rothmaler<sup>2</sup> necessitate a revision of this view. These findings have some cytogenetic, evolutionary and phyto-geographic implications which are briefly discussed here.

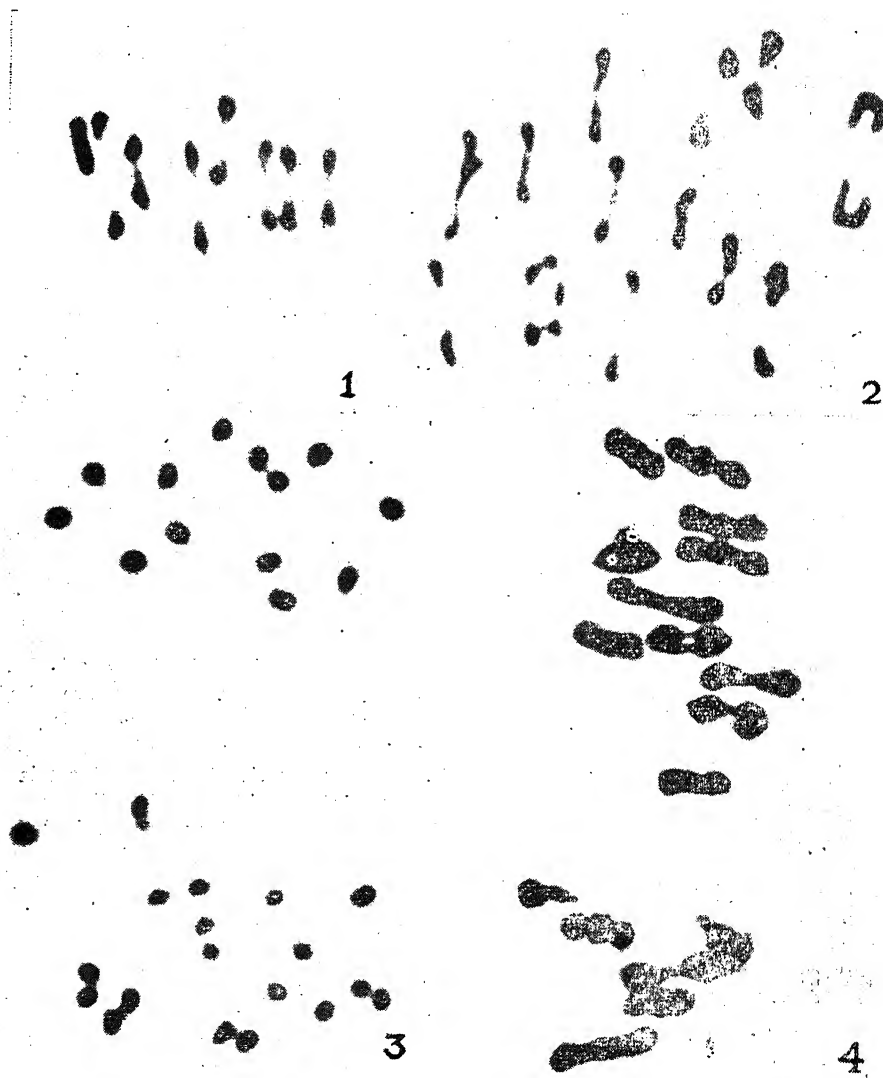
The genus has been divided into two sections,<sup>3</sup> *Antirrhinum* and *Særorrhinum*, which are distributed in the Mediterranean region of Europe and South-Western parts of North America respectively. From the European element of the genus 16 species have been worked out cytologically so far. All these are diploid ( $n=8$ ; Fig. 1). Furthermore, there is a preponderance of self-incompatible and cross-fertilized species.<sup>4</sup> However, gene flow between

species is restricted by bee specificity<sup>5</sup> in relation to colour, size and structure of flower and ecological isolation.<sup>6</sup> As a result of this, in a mixed population of different species, like *A. majus* and *A. glutinosum*, there is ordinarily little interspecific hybridization although the species cross readily when pollinated by hand.<sup>7</sup> There appear to be no barriers to recombination once hybridization between two subspecies or species is effected. Fertile and segregating progenies<sup>8,9</sup> are known to result from hybrids involving *A. majus* with *A. glutinosum*, *A. ibanyezii*, *A. latifolium*, *A. linkianum*, *A. molle* and *A. sempervirens*. The flowers in some F<sub>4</sub> segregants of *A. majus* × *A. glutinosum* resemble an allied genus *Rhinanthus*.<sup>10</sup> Such "explosive variability" is disharmonious and non-functional. The hybrids have normal meiosis but possibly

possess cryptic structural hybridity as is apparent from pachytene studies.<sup>11</sup>

It is clear from the above that European species of *Antirrhinum* have an ecospecific pattern in which species differentiation is maintained at diploid level by ethological and ecogeographic isolation. Accordingly, any polyploids that ensue would have auto- or segmental allopolyploid characters. Such polyploids, unaided by other supportive mechanisms, have inherent limitations and are unable to establish in nature, although autopolyploids of the ornamental *A. majus* are a tremendous success under garden condi-

tions. They are now widely grown by florists and gardeners and we have also developed our own tetra-snapdragon lines which have given a high performance. The autopolyploids are hardier, more vigorous, stouter and stockier and possess larger flowers than the corresponding diploids. They have a high fertility even though there are 1 to 8 IVs at meiosis (Fig. 2). Furthermore, since no aneuploid or triploid individuals were recovered in large populations raised by us, we presume that the few cytological irregularities (Fig. 3) seen during meiosis are of no consequence. In other words, sex cells carrying



FIGS. 1-4. Figs. 1-3. *A. majus*. Fig. 1. Diploid 8 II. 1 III + 8 II + 1 I and Anaphase I 13-19 distribution. Figs. 2-3. Autotetraploid Metaphase I 3 IV + 16 II. All,  $\times 2,000$ . Fig. 4. *A. multiflorum* Natural tetraploid



deviant numbers are weeded out during gametic and/or zygotic selection and only those with complete diploid number are selected. With the increase in level of heterozygosity by inter-variety hybridization, there is an increase in fertility as was also observed earlier.<sup>12</sup> However, even with the above advantages, it is problematic if autotetraploid *A. majus* can establish in open competition in its own geographic range.

Yet another factor probably not always conducive to the institution and ultimate stabilization of polyploids in the European section of the genus relates to the mode of interaction between the alleles controlling self-compatibility/compatibility in interspecific hybrids and polyploids ensuing from them.<sup>13</sup>

The available data on the Section *Saerorhinum* indicates a situation which in some ways is in contrast to what is found in the Section *Antirrhinum*. Out of the 5 American species worked out cytologically so far, four are polyploids and one is a diploid ( $n=8$ ). Two of the polyploids are tetraploid ( $n=16$ ) while the remaining two possess  $n=15$ . A large number of pollen mother cells of *A. multiflorum* examined by us at diakinesis and MI revealed no multivalent formation (Fig. 4). The same was reported earlier in *A. coulterianum*, *A. elmeri* (both  $n=15$ ) and *A. nuttallianum* ( $n=16$ ).<sup>2</sup> The typical allopolyploid behaviour during meiosis in all the four species may indicate a strong differentiation of the parental genomes. There is one such case (*A. orontium*  $\times$  *A. meonanthum*) of total lack of pairing and sterility among European species.<sup>13</sup> Alternatively, some other mechanism may be involved which makes the homeologous or even homologous genomes of the parents to function as in a genomic allopolyploid. Furthermore, the species with  $n=15$  may either be secondary polyploids at hypotetraploid level ( $4x-2$ ) or allopolyploids between species with  $n=8$  and

hitherto undiscovered species with  $n=7$ . All these points can be clarified only after a thorough study of the North American species.

In conclusion it may be pointed out that the present data are indicative of an interesting cytogenetic difference between the two phyto-geographic elements of *Antirrhinum*. The European species appear to be at diploid level with genomes not sufficiently differentiated, while the American species tend to be polyploid. The gene flow and consequent breakdown in self-incompatible out-breeding European species appears to be prevented by ethological and ecogeographical barriers. If future cytogenetic studies confirm this difference, then *Antirrhinum* is an interesting genus showing evolutionary divergence in similar environments in two different continents.

Our thanks are due to Dr. L. B. Singh, Director, for facilities and to Mr. T. K. Sharma for the photographs illustrating this paper.

1. Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, London, 1955.
2. Gunther, E. and Rothmaler, W., *Biol. Zbl.*, 1963, **82**, 95.
3. Rothmaler, W., "Taxonomische Monographie der Gattung *Antirrhinum*," *Feddes Rep.*, Beih. 136, Berlin, 1956.
4. Fryxell, P. A., *Bot. Rev.*, 1957, **23**, 135.
5. Grant, V., *The Origin of Adaptations*, London, 1963.
6. Baur, E., *Zeit. Ind. Abst. u. Vererb.*, 1932, **63**, 256.
7. Mather, K., *Heredity*, 1947, **1**, 175.
8. Baur, E., *Einführung in die Vererbungslehre*, 5 and 6 Auflage, Berlin, 1922.
9. Crane, M. B. and Lawrence, W. J. C., *The Genetics of Garden Plants*, London, 1952.
10. Lohs, J. P., *Evolution by Means of Hybridization*, The Hague, 1916.
11. Ernst, H., *Zeit. Bot.*, 1939, **34**, 81.
12. Sparrow, A. H., Ruttle M. L. and Nebel, B. R., *Amer. J. Bot.*, 1942, **29**, 711.
13. Harrison, B. J. and Darby, L. A., *Nature*, 1955, **176**, 982.

## LETTERS TO THE EDITOR

A NOTE ON PSEUDO STATIONARY  
GAS FLOWS

In this note, it is shown that no two pseudo stationary gas flows of the same fluid can have the same streak-line pattern.

The equations governing an unsteady flow of a non-viscous compressible fluid in the absence of external forces are given in the usual notation.<sup>1</sup>

$$\frac{d\rho}{dt} + \rho \operatorname{div} \vec{q} = 0 \quad (1)$$

$$\frac{d\vec{q}}{dt} = \frac{\partial \vec{q}}{\partial t} + \vec{q} \cdot \nabla \vec{q} = -\frac{1}{\rho} \nabla P \quad (2)$$

$$\frac{dS}{dt} = 0 \quad (3)$$

On using the transformations given by Premkumar,<sup>1</sup> namely

$$x_i = \frac{1}{t} a_i, \quad i = 1, 2, 3$$

the equations (1), (2) and (3) are changed into

$$\nabla' \cdot (\rho \vec{Q}) = -3\rho \quad (4)$$

$$(\vec{Q} \cdot \nabla') \vec{Q} + \vec{Q} = -\frac{1}{\rho} \nabla' P \quad (5)$$

$$\vec{Q} \cdot \nabla' S = 0 \quad (6)$$

where  $\vec{Q}$  may be conveniently called the pseudo velocity.

Let  $\vec{Q}$  and  $\vec{Q}_1$  define the pseudo velocities of two pseudo stationary flows with identical streak-lines. Hence

$$\vec{Q}_1 = \lambda \vec{Q} \quad (7)$$

where  $\lambda$  is a scalar.

On applying equation (4) to the two flows, we have

$$\nabla' \cdot (\rho \vec{Q}) = -3\rho \quad (8)$$

$$\nabla' \cdot (\rho \vec{Q}_1) = -3\rho \quad (9)$$

On using (7) and (8), equation (9) simplifies to

$$\vec{Q} \cdot \nabla' \lambda = 3(\lambda - 1). \quad (10)$$

If  $\vec{q}$  and  $\vec{q}_1$  are respectively the velocity vectors of the compressible flows that give rise to the pseudo stationary flows defined by the

pseudo-velocity vectors  $\vec{Q}$  and  $\vec{Q}_1$ , then from the transformations [1], we have

$$\vec{q}_1 = \lambda \vec{q} + \vec{r}' \quad (11)$$

and

$$\vec{q} = \vec{Q} + \vec{r}' \quad (12)$$

On eliminating  $\vec{r}'$ , from (11) and (12), we obtain

$$\vec{q}_1 - \vec{q} = (\lambda - 1) \vec{Q} \quad (13)$$

On using (1) and (13), we get

$$\nabla \cdot (\vec{q}_1 - \vec{q}) = \frac{\nabla'}{t} \cdot (\lambda - 1) \vec{Q} = 0. \quad (14)$$

Equations (10) and (14) taken together give

$$\nabla' \cdot \vec{Q} = -3. \quad (15)$$

On using (12), equation (15) reduces to

$$\nabla \cdot \vec{q} = 0 \quad (16)$$

which when substituted in (1) shows that the fluid is incompressible.

Hence the result in the case of spatial flows.

A proof on similar lines can be given for plane flows.

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Osmania University,  
Hyderabad-7, September 11, 1967.

1. Premkumar, 'Variation of flow quantities along streak-lines and their principal normals and binormals in three dimensional pseudo stationary gas flows,' *Proc. Sixth Congress Theor. Appl. Mechanics*, Delhi, 1960, p. 43.

ROTATIONAL ANALYSIS OF THE  
 $\beta$  BAND SYSTEM OF SiF MOLECULE

THE spectrum of SiF molecule has been studied by a number of workers.<sup>1-9</sup> The bands of the  $\beta$ -system of this molecule were obtained under favourable conditions with a high-dispersion concave grating, and the results of the rotational analysis of the (0, 0) band are presented in this note.

The SiF bands were photographed in the second order of a 35-ft. concave grating spectrograph (30,000 lines/inch) with a dispersion of 0.35 Å/mm. Kodak II-0 plates were used and with a slit-width of 25  $\mu$  an exposure of 8

hours was found sufficient. Atomic lines of thorium, excited in a thorium iodide electrodeless discharge tube, were used as reference. Measurements of sharp lines are estimated to be accurate to  $0.04 \text{ cm}^{-1}$ . The (0, 0) band of B-X<sub>1</sub> sub-system is partially superposed by the (0, 0) band of B-X<sub>2</sub> sub-system and the (0, 2) band of B-X<sub>1</sub> sub-system of PbF.

#### ANALYSIS AND RESULTS

The (0, 0) bands of B-X<sub>1</sub> and B-X<sub>2</sub> sub-systems have been measured and analysed. The print of the (0, 0) band of B-X<sub>2</sub> sub-system is given in Fig. 1. The three main branches P<sub>1</sub>, Q<sub>1</sub>, R<sub>1</sub> and a few lines of <sup>s</sup>R<sub>21</sub> could be obtained in the (0, 0) band of B-X<sub>1</sub> sub-system whereas five branches could be picked out in the (0, 0) band of B-X<sub>2</sub> sub-system. Apart from the three main branches (P<sub>2</sub>, Q<sub>2</sub> and R<sub>2</sub>) the satellite branch <sup>o</sup>P<sub>12</sub> could be traced and a few lines of <sup>o</sup>R<sub>12</sub> could also be picked out at high J values. The other satellite branch <sup>p</sup>Q<sub>12</sub> was not resolved.

$(x\sigma)^2(v\Pi)$  which gives rise to a X <sup>2</sup>Π<sub>γ</sub> state. The first excited state having the electron configuration  $\dots(z\sigma)^2(y\sigma)^2(\omega\Pi)^4(x\sigma)^2(u\sigma)$  would give A <sup>2</sup>Σ<sup>+</sup> state. This has been confirmed by Johns and Barrow<sup>5</sup> by the rotational analysis of A-X system of SiF. The electron configuration of the second excited state  $\dots(z\sigma)^2(y\sigma)^2(\omega\Pi)^4(x\sigma)(v\Pi)^2$  would also give B <sup>2</sup>Σ state and has been predicted by Asundi and Samuel,<sup>1</sup> Eyster<sup>4</sup> and Verma.<sup>9</sup> While B <sup>2</sup>Σ state corresponds to Hund's case (b), the X <sup>2</sup>Π<sub>γ</sub> state, with a doublet separation of  $162 \text{ cm}^{-1}$  would correspond to case (a). As expected, each band consists of two sub-bands with the formation of P<sub>1</sub> and Q<sub>1</sub> heads in <sup>2</sup>Σ-<sup>2</sup>Π<sub>1,2</sub> sub-system and <sup>o</sup>P<sub>12</sub> and P<sub>2</sub> heads in <sup>2</sup>Σ-<sup>2</sup>Π<sub>3,2</sub> sub-system (bands are violet degraded). In <sup>2</sup>Σ-<sup>2</sup>Π (case a) transition, twelve branches, six in each sub-band are expected. In the <sup>2</sup>Σ-<sup>2</sup>Π<sub>1,2</sub> component of the (0, 0) band, three main branches and only few lines of <sup>s</sup>R<sub>21</sub> could be picked out, because the satellite branches could not be

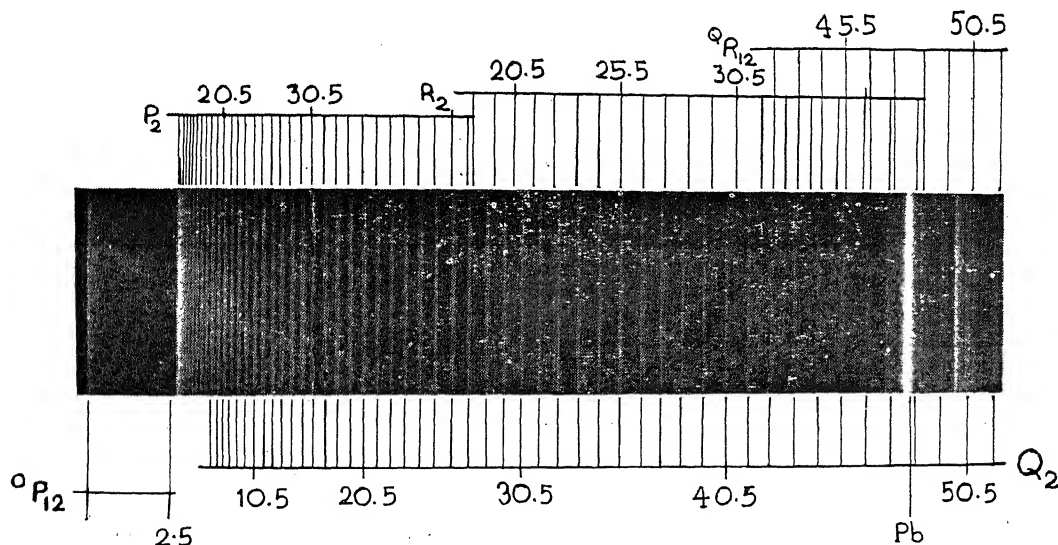


FIG. 1. (0, 0)<sub>3/2</sub> band of SiF (β-system).

The relative numbering is obtained by equating the combination differences formed by the R and Q branches with those formed by P and Q branches. The usual procedure of plotting  $\Delta_1 F(J)$  versus J and shifting the abscissa scale so that the straight line cuts it at  $J = -1$  has been followed to assign the absolute J numbering.

#### DISCUSSION

The electron configuration of the ground state of SiF can be written as  $\dots(z\sigma)^2(y\sigma)^2(\omega\Pi)^4$

resolved. In the case of <sup>2</sup>Σ-<sup>2</sup>Π<sub>3/2</sub> component, in addition to the three main branches <sup>o</sup>P<sub>12</sub> and <sup>o</sup>R<sub>12</sub> could also be traced. The other satellite branch <sup>p</sup>Q<sub>12</sub> could not be resolved. The results confirm that the transition involved is <sup>2</sup>Σ-<sup>2</sup>Π<sub>γ</sub> (case a) as has been predicted earlier.

The authors are thankful to Prof. N. L. Singh for his interest in the work. One of us (O. N. Singh) is thankful to C.S.I.R. (India) for financial assistance.

TABLE I

Rotational constants of the  $\beta$  band system of  
SiF molecule

$B_0'' = 0.57724 \text{ cm.}^{-1}$ ( ${}^2\Pi_{1/2}$ )
$B_0' = 0.58104 \text{ cm.}^{-1}$ ( ${}^2\Pi_{3/2}$ )
$B_0'' = 0.62510 \text{ cm.}^{-1}$ ( ${}^2\Sigma$ )
$D_0'' = 1.90 \times 10^{-6} \text{ cm.}^{-1}$
$D_0' = 0.91 \times 10^{-6} \text{ cm.}^{-1}$
$\nu_0^{(1)} = 34719.39 \text{ cm.}^{-1}$
$\nu_0^{(2)} = 34558.23 \text{ cm.}^{-1}$
$A_0 = 161.92 \text{ cm.}^{-1}$
$r_0'' = 1.604 \text{ \AA}$
$r_0' = 1.544 \text{ \AA}$
$I_0'' = 48.318 \times 10^{-40} \text{ gm. cm.}^2$
$I_0' = 44.765 \times 10^{-40} \text{ gm. cm.}^2$
$\gamma = 0.0103 \text{ cm.}^{-1}$

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September 15, 1967.

1. Asnndi, R. K. and Samuel, R., *Proc. Ind. Acad. Sci.*, 1936, **3 A**, 346.
2. Barrow, R. F., Butler, D., Johns, J. W. C. and Powell, J. L., *Proc. Phys. Soc.*, 1959, **73**, 317.
3. Dowell, W. H. and Barrow, R. F., *Ibid.*, 1951, **64 A**, 98.
4. Eyster, E. H., *Phys. Rev.*, 1937, **51**, 1078.
5. Johns, J. W. C. and Barrow, R. F., *Proc. Phys. Soc.*, 1958, **71 A**, 476.
6. Johnson, R. C. and Jenkins, H. G., *Proc. Roy. Soc.*, 1927, **116**, 327.
7. Porlezza, *Rend. Acad. Lincei*, 1911, **20**, 1920.
8. —, *Ibid.*, 1924, **33**, 283.
9. Verma, R. D., *Can. J. Phys.*, 1962, **40**, 586.

## RAMAN SPECTRUM OF COUMARIN

CHANGES in the Raman Spectrum of Coumarin due to change of state were first noted by Venkateswaran.<sup>1</sup> In this note the relative intensities of Raman lines in the solid and molten states of Coumarin are reported. The spectra were obtained using a Zeiss three prism spectrograph and the intensity estimates made with a L'epho microphotometer. Identical conditions have been maintained while recording the spectra of the substance in the two states.

In the case of the solid the peak intensities of the lines are compared with that of the 1174  $\text{cm.}^{-1}$  which is taken to have an intensity of 10. The line at 1180  $\text{cm.}^{-1}$  is taken as standard in the case of molten solid. The intensities and frequencies are given in Table I. The contours of the lines are different in the two phases of the substance. In the solid phase the lines are slightly broad and diffuse. From Table I, it can be noted that the relative

intensities as well as the frequencies undergo marked changes due to the change of state. C-H frequencies are not reported here.

TABLE I

Raman frequencies of Coumarin in solid and molten states ( $\text{cm.}^{-1}$ )

Solid	Molten
..	367 (1.2)
448 (1.6)	449 (5.6)
490 (0.6)	493 (1.6)
526 (1.0)	526 (1.2)
726 (1.0)	726 (1.6)
764 (1.8)	761 (1.7)
..	881 (0.5)
1030 (1.0)	1030 (1.7)
1098 (1.0)	1101 (1.7)
1123 (2.6)	1125 (3.8)
1153 (2.7)	1156 (3.3)
1174 (10)	1180 (10)
1228 (3.8)	1232 (4.6)
..	1261 (1)
1324 (2.0)	1329 (4.2)
1454 (2.9)	1450 (1.8)
1485 (1.7)	1492 (2.8)
1563 (8.3)	1568 (9.8)
1601 (8.9)	1611 (9.2)
1619 (5.0)	1626 (6.6)
1706 (3.0)	..
1726 (2.6)	1732 (9.2)

Most of the lines have slightly lower frequency and intensity in the solid. But the lines at 764 and 1454  $\text{cm.}^{-1}$  show the reverse trend. The C=C frequency of Coumarin in  $\text{CCl}_4$  (1570, 1610, 1625)<sup>2</sup> compares favourably with those for the molten solid (1568, 1626). The C=O frequency (1732) is not only reduced in intensity but also has become diffuse and split into two in the solid.

Murthy and Seshadri have proposed a mechanism based on hydrogen bonding for the lowering and splitting of the carbonyl bond.<sup>2</sup> Another reason may be the existence of correlation field splitting of non-degenerate vibrational bands of molecular crystals as predicted by Hexter.<sup>3</sup>

Seven low frequency lattice lines are observed and are given in Table II (visual intensities are given in brackets). Venkateswaran has observed five lattice lines.<sup>4</sup> Two more lines (29 and 146  $\text{cm.}^{-1}$ ) are reported here for the first time.

TABLE II

Lattice frequencies of Coumarin ( $\text{cm.}^{-1}$ )

29	39	54	67	92	112	146
(1)	(3)	(10)	(2)	(8)	(3)	(2)

When the substance is molten there is a continuous wing extending upto 90  $\text{cm.}^{-1}$  in the place of the lattice-lines. Further work in this direction is in progress.

One of the authors (C.P.G.) is thankful to Government of India for the award of a Junior Research Fellowship.

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Dept. of Physics, K. VENKATESWARLU.  
Alwaye-4, December 7, 1967.

1. Venkateswaran, C. S., *Curr. Sci.*, 1938, 6, 328.
2. Murthy, G. V. L. N. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1038, 8, 519.
3. Hexter, R. M., *J. Chem. Phys.*, 1960, 33, 1833.
4. Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, 1938, 8, 448.

### K-SHELL PHOTOELECTRIC CROSS-SECTIONS OF 145 keV GAMMA-RAYS IN VARIOUS ELEMENTS

By using the technique of measuring the absolute yield of fluorescent K-radiation following the ejection of K-shell electrons when a target is irradiated with gamma-rays, we have extended our earlier measurements<sup>1-3</sup> to 145 keV gamma-rays. In addition to the photoelectric interaction, the K-radiation may also be produced by the Compton scattering of gamma-rays from K-shell electrons and the ionization caused by photo and Compton electrons. Compton scattering cross-section from K-shell electrons has been found by many investigators<sup>4-6</sup> to be equal to that from free electrons and contribution of this effect comes out to be of the order of 1%. Using the data of Rester and Dance<sup>7</sup> the contribution of K-shell ionization by photo and Compton electrons was calculated and found to be less than 0.5%. The contribution of both these effects is within our experimental error and thus our results are essentially for the photoelectric interaction.

The experimental technique used is the same as reported earlier.<sup>1,2</sup> A 100 cm. strong source of  $Ce^{141}$  was used for 145 keV gamma-rays and a graded absorber was placed at the mouth of source slit to absorb 36 keV X-rays coming from the internal conversion in  $Ce^{141}$ . A 2.5 cm. dia.  $\times$  2.5 cm. height NaI(Tl) spectrometer was used to measure the intensity of K-shell X-rays following the photoelectric interaction. Targets of lead, gold, tungsten, tin and silver were in the form of metallic foils, each of radius 1.25 cm. Holmium ( $Ho_2O_3$ ), dysprosium ( $Dy_2O_3$ ) and barium ( $Ba_2SO_4$ ) were used in powdered form filled uniformly in thin aluminium caps covered with a fine cellu-tape layer. Target thickness was varied from 0.04 to 0.40 gm./cm.<sup>2</sup>. The K-shell photoelectric cross-sections were calculated from the measured yield of the K-shell

X-rays by applying geometrical and other corrections such as solid angle, self-absorption in the target, detection efficiency of X-rays<sup>8</sup> and gamma-rays,<sup>9</sup> fluorescent yield,<sup>10</sup> etc., as explained earlier.<sup>1-3</sup> The results obtained are shown in Fig. 1 along with the theoretical results of Hubbel and Berger.<sup>11</sup> Agreement with theory is good within the range of experimental uncertainty.

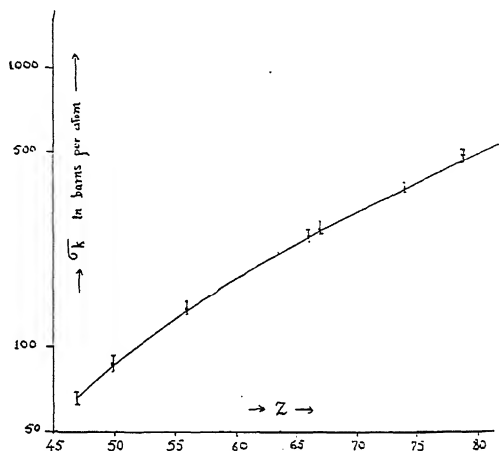


FIG. 1. K-shell photoelectric cross-sections versus atomic number. Curve represents the values of Hubbel and Berger.

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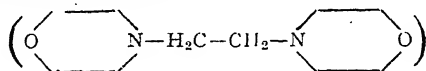
Physics Department, B. S. GHUMMAN.  
Punjab University, H. S. SAHOTA.  
Patiala-4, October 17, 1967. B. S. SOOD.

1. Ghumman, B. S., Anand, S. and Sood, B. S., *Indian J. Pure Appl. Phys.*, 1966, 5, 70.
2. —, — and —, *Curr. Sci.*, 1960, 35, 540.
3. Oberoi, R. S., Radhe Mohan and Sood, B. S., *Ibid.*, 1965, 34, 372.
4. Motz, J. W. and Misson, G., *Phys. Rev.*, 1961, 124, 1458.
5. Varma, J. and Eswaran, A., *Ibid.*, 1962, 127, 1197.
6. Brini, D., Fuschini, E., Grimelini, N. T. and Murty, D. S. R., *Nuovo Cimento*, 1960, 16, 727.
7. Rester, D. H. and Dance, W. E., *Phys. Rev.*, 1966, 152, 1.
8. Ghumman B. S., Anand, S. and Sood, B. S., *Curr. Sci.*, 1967 36, 484.
9. Leutz, H., Schulz, G. and Van Gelderan, L., *Nuc. Instr. Method.*, 1966, 40, 257.
10. Wapstra, A. H., Nigh, G. H. and Van Lieshot, R., *Nuclear Spectroscopy Tables*, North Holland Publishing Company, Amsterdam 1959.
11. Hubbel, J. H. and Berger, M. J., *NBS Report*, 1966, p. 8681.

# CO-ORDINATION COMPLEXES OF MORPHOLINE AND DIMORPHOLINOETHANE



dimorpholinoethane



have different types of co-ordination possibilities to metal ions, namely either through nitrogen or oxygen or through both. Over the last two years we have prepared many complexes of the two ligands with various metal halides, nitrates and perchlorates. The complexes were generally prepared by the addition of excess of morpholine or dimorpholinoethane to alcoholic solutions of the respective almost anhydrous metal salts, washing the precipitated complexes first with ethyl alcohol and then with ethyl ether. The following complexes of morpholine (M) were successfully isolated using the above technique:  $\text{ZnCl}_2 \cdot 2\text{M}$ ,  $\text{CdCl}_2 \cdot 2\text{M}$ ,  $\text{HgCl}_2 \cdot 2\text{M}$ ,  $\text{CoCl}_2 \cdot 2\text{M}$ ,  $\text{CuCl}_2 \cdot 2\text{M}$ ,  $\text{Cu}(\text{NO}_3)_2 \cdot \text{M}$ ,  $\text{Cu}(\text{NO}_3)_2 \cdot 2\text{M}$ ,  $\text{Cu}(\text{ClO}_4)_2 \cdot \text{M}$ . While our work was in progress Ahuja<sup>1</sup> has very recently reported the isolation and spectral features of the complexes of morpholine with halides of divalent Mn, Co, Cu, Zn and Cd. We have carried out in addition to spectral studies, measurements of electrical conductance and magnetic susceptibility which will be reported in detail later. The nickel complex,  $\text{NiM}_4\text{Cl}_2$ , could not be isolated by direct methods. However, it was prepared by us for the first time by the displacement of pyridine from  $\text{NiPy}_4\text{Cl}_2$  with morpholine. Its structural features are being studied.

Dimorpholinoethane gave crystalline 1:1 complexes with  $\text{CoCl}_2$ ,  $\text{NiCl}_2$ ,  $\text{CuCl}_2$ ,  $\text{Cu}(\text{NO}_3)_2$ ,  $\text{Cu}(\text{ClO}_4)_2$ ,  $\text{ZnCl}_2$ ,  $\text{CdCl}_2$  and  $\text{HgCl}_2$  when it was added to the alcoholic solutions of the almost anhydrous metal salts. The complexes are being characterised by X-Ray, spectral, electrical conductance and magnetic susceptibility measurements.

Phase equilibrium studies at 30° C. of systems involving morpholine hydrochloride, (MHCl), water and  $\text{CuCl}_2$ ,  $\text{ZnCl}_2$  or  $\text{CdCl}_2$  have established the formation of the following compounds:  $\text{CuCl}_2 \cdot 2\text{MHCl}$ ,  $\text{ZnCl}_2 \cdot 2\text{MHCl}$ ,  $2\text{CdCl}_2 \cdot \text{MHCl}$ ,  $\text{CdCl}_2 \cdot \text{MHCl}$ . The X-Ray structural investigation of morpholine (at low temperature), morpholine complexes and morpholinium compounds has been taken up.

We are grateful to M/s. Jefferson Chemical Company, U.S.A. and to Chemische Werke Hüls, Germany, for their generous gifts of morpholine and dimorpholinoethane, respectively.

Department of Chemistry, D. VENKAPPAYYA.  
Indian Institute of G. ARAVAMUDAN.  
Technology,  
Madras, December 5, 1967.

1. Ahuja. I. S., *J. Inorg. Nucl. Chem.*, 1967, 29, 2091.

## THERMAL DEHYDRATION OF SYNTHETIC HYDROXYLAPATITE

HYDROXYLAPATITE (written as HA for brevity),  $3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{Ca}(\text{OH})_2$ , is the inorganic constituent of animal bones and teeth. It is isomorphous with the naturally occurring fluorapatite,  $3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{CaF}_2$ . Because of its ability to undergo both cationic and anionic exchange reactions, it has been the subject of extensive physico-chemical investigations.<sup>1</sup> Since the earlier work<sup>2-5</sup> could not establish the exact nature of water bound up with samples of HA obtained by precipitation from aqueous solutions, it was decided to carry out thermal dehydration studies in air on such samples under atmospheric pressure.

The various aspects of preparation of HA by precipitation from aqueous solutions containing  $\text{Ca}^{2+}$  and  $\text{PO}_4^{3-}$  have earlier been investigated in detail.<sup>6-7</sup> A sample of HA was prepared using the method of Collin.<sup>8</sup> All chemicals used were either of A.R. (B.D.H.) or of extra pure (E. Merck) grade. Stoichiometric quantities of diammonium hydrogen phosphate and calcium nitrate solutions required to form HA were mixed by adding the former to the latter at a slow rate. Throughout the addition the medium of precipitation was kept well stirred and maintained at a pH of 12 by adding ethylenediamine. Since the presence of carbon dioxide leads to the formation of carbonate-apatite, water free from it was used to prepare the solutions. In addition, air free from carbon dioxide was bubbled through the solutions during precipitation. To improve crystallinity of the precipitate, it was aged by keeping in contact with the mother liquor overnight after refluxing for about 30 min. Later it was filtered and washed till the washings were neutral. It was finally washed with acetone and dried in air. The sample was analysed by the method of Washburn and Shear.<sup>9</sup> The experimental Ca/P ratio (1.697) was found to be in agreement with the theoretical value (1.667).

A convenient weight of the sample was heated in a silica crucible to different increasing temperatures at intervals of about 50° C. upto about 1000° C. At each temperature the heating was continued till constancy of weight was attained. Figure 1 represents the loss of water

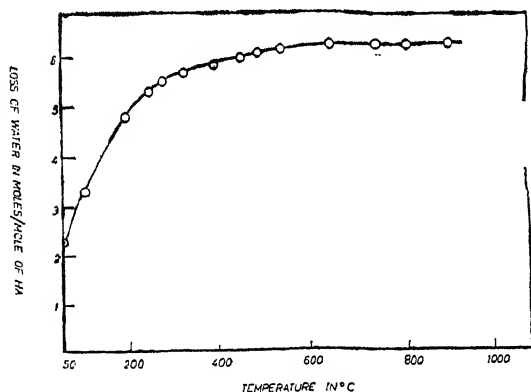


FIG. 1. Loss of water of synthetic HA, as function of temperature.

in moles per mole of HA as a function of temperature. The uniform loss of water as indicated by the curve suggests the absence of any hydrate<sup>10</sup> within the temperature range investigated. Further, from the lack of discontinuity in the curve it can be concluded that the water of constitution amounting to one mole per mole of HA was not given out upto 1000° C. Thus the water given out was supposed to be of zeolitic type on the basis of the similarity of the dehydration curve of synthetic HA with that of zeolites.<sup>11</sup> The trapping of water within the bulk of HA is facilitated by its large surface area consequent upon its well-established colloidal nature in aqueous solutions.<sup>12</sup>

Thanks are due to Prof. G. B. Singh for providing facilities and to Prof. T. R. Anantharaman for permitting us to carry out the high temperature work in the Department of Metallurgy.

Dept. of Chemistry, N. S. CHICKERUR.  
Banaras Hindu Univ., T. S. B. NARASARAJU.  
Varanasi, September 18, 1967.

1. Neuman, W. F. and Neuman, M. W., *Chem., Rev.*, 1953, **53**, 1.
2. Hayek, E., Lechleitner, J. and Boehler, W., *Ang. Chem.*, 1955, **67**, 326.
3. —, Muellner, F. and Koller, K., *Monatsch.*, 1951, **82**, 959.
4. Schleede, A., Schmidt, W. and Kindt, H., *Z. Elektrochem.*, 1932, **38**, 633.
5. Arnold, P. W., *Trans. Faraday Soc.*, 1950, **46**, 1061.

6. Hayek, E. and Stadlemann, W., *Ang. Chem.*, 1955, **67**, 327.
7. Rathje, W., *Ber.*, 1941, **74**, 342.
8. Collin, R. L., *J. Am. Chem. Soc.*, 1959, **81**, 5275.
9. Washburn, M. L. and Shear, M. J., *J. Biol. Chem.*, 1932-33, **21**, 99.
10. Moeller, T., *Inorganic Chemistry*, Asia Publishing House, Bombay-1, 1962, p. 499.
11. Milligan, W. O., *J. Phys. Chem.*, 1937, **41**, 1029.
12. Rootare, H. M., Deitz, V. R. and Carpenter, F. G., *J. Col. Sci.*, 1962, **17**, 179.

## A COMPOSITE DOLERITE DYKE FROM TIRUPATI, SOUTH INDIA

The composite dolerite dyke is exposed 8 km. south of Tirupati by the right side of the Tirupati-Rayalacheruvu Road near the village Ramapuram. It is coarse-grained 10 to 12 m. wide and 30 to 35 m. long as measured on an erosion surface in the low levels of the region. The dyke is highly altered (Fig. 2), contains 42% of pyroxene and hornblende, 46% of altered and unaltered plagioclase ( $An_{50-55}$ ) and 12% of iron ores, biotite and other accessory minerals.

The dolerite dyke has intruded into granite and has developed one weak plane near its centre parallel to its borders (Smellie, 1914). Silicic residuum, the extreme end product of differentiation of doleritic magma has been injected into the dyke along the plane of weakness, making sharp contacts with the dolerite (Fig. 1). It forms a band with a variable width, the maximum being 50 cm. The silicic band is white in colour consisting of quartz and plagioclase ( $An_{5-15}$ ) intergrown together. The intergrowth of the two minerals imparts a typical granophyric texture to the band (Fig. 3). It consists of a little of ferromagnesian minerals seldom exceeding 10% in the whole band. The occurrence of interstitial granophyre in the differentiated dolerite dykes is common; but its occurrence as a separate band in the form of composite intrusion (Thomas and Baily, 1924; Tyrrell, 1929) is rare and not reported from India.

Most of the silicic band shows granophyric texture. The texture may be developed by a primary process (Vogt, 1930; Hughes, 1960; Dunham, 1965) such as simultaneous crystallization of quartz and feldspar or by a secondary process (Walker and Poldervaart, 1949; Black, 1954; Govindarajulu and Asadulla Sharief, 1967) such as diffusion and deuteric replacement. Evidences suggest that the granophyric texture of the silicic band in this composite intrusion,

is developed by a secondary process, viz., deuterite replacement. The plagioclase ( $An_{7-10}$ ) and the quartz in the band primarily crystallized with a granitic texture (Fig. 4), and later attacked by the deuterite agents together with the

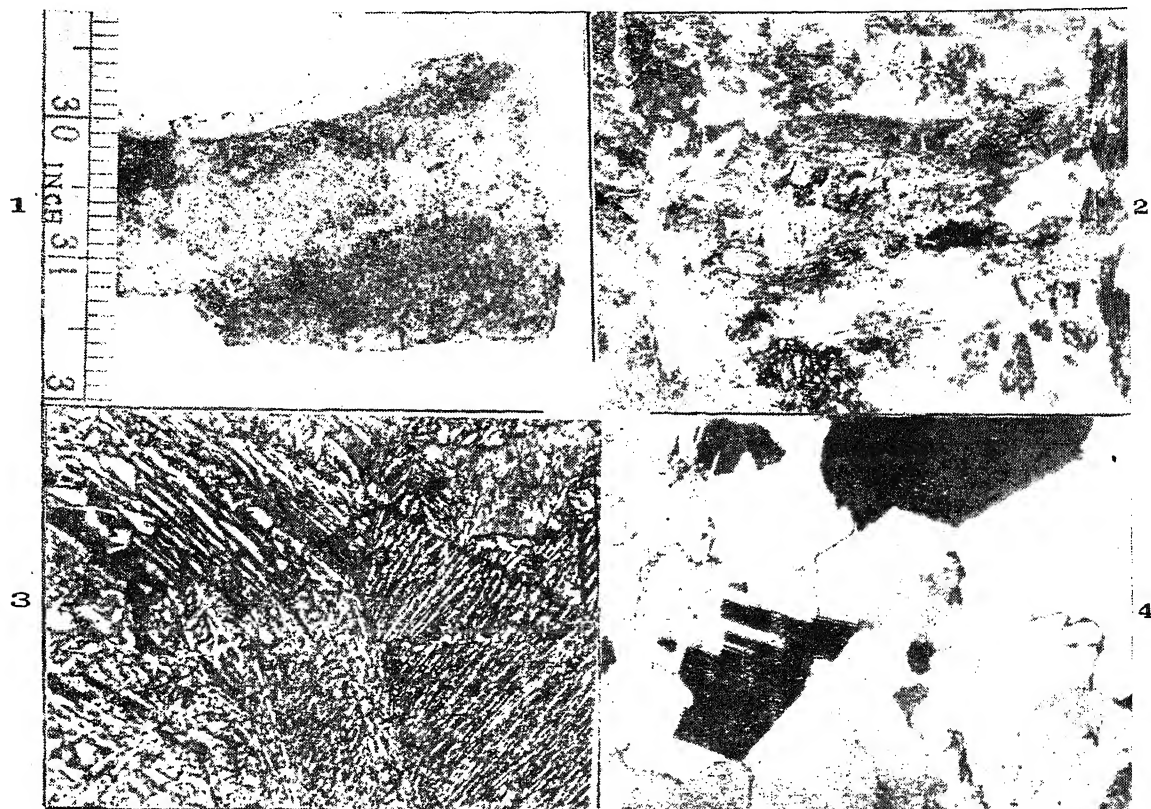
helpful suggestions. U.G.C.'s Financial assistance for fieldwork is gratefully acknowledged.

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September 30, 1967.



FIGS. 1-4. Fig. 1. Hand specimen showing contact between the dolerite (bottom) and granophyre (top). Fig. 2. Altered dyke. Note the development of amphibole around the pyroxene and sericite in the cores of plagioclase. Fig. 3. Granophyric texture as seen in the silicic band. Fig. 4. Granitic texture as seen in the silicic band.

dolerite. The silica-bearing solutions replaced the plagioclase ( $An_{7-10}$ ) along the twinning, composition and cleavage planes, imparting a typical granophyric texture to the band. The replacement is complete in most parts of the rock. However the rock escaped replacement here and there (Fig. 4). The effect of deuterite agents on the dyke is seen in the transformation of pyroxene into amphibole, plagioclase into sericite and zoisite and development of biotite here and there (Fig. 2).

The author thanks professor M. G. Chakrapani Naidu and Dr. K. V. Suryanarayana for their

1. Black, G. P., *Geol. Mag.*, 1954, **91**, 257.
2. Dunham, A. C., *Ibid.*, 1965, **102**, 8.
3. Govindarajulu, B. V. and Asadulla Sharief, *Curr. Sci.*, 1967, **36**, 46.
4. Hughes, C. J., *Quart. Jour. Geol. Soc., Lond.*, 1960, **116**, 111.
5. Smellie, *Trans. Geol. Soc. Glasgow*, 1914, **15**, Part 2, 125.
6. Thomas, H. H. and Baily, E. B., *Mull Memoir*, 1924, p. 32.
7. Tyrrell, G. W., *The Principles of Petrology*, 1929, p. 31.
8. Vogt, J. H. L., *Skr. Norsk. Vidensk. Akad. 1 Mat-Natur Kl.*, 1930, No. 8.
9. Walker, F. and Poldervaart, A., *G.S.A. Bull.*, 1949, **60**, 674.



**AN INTERESTING DYKE NEAR  
ARCHAEAN-CUDDAPAH BOUNDARY,  
VELDURTHI, KURNOOL DISTRICT, A.P.**

DYKE activity at the end of Archæan period is very prominent throughout the Peninsular India. Dykes cutting across Cuddapah rocks near the Archæan-Cuddapah boundary are not reported so far, although several traps and sills are reported within lower Cuddapah. King (1872) mentions that some trap intrusives have "even flowed beyond the edge of the KADAPAH rocks in their northern area, and touched on the crystallines or gneiss rocks". The author in his Geological field mapping of sediments in an area east of Veldurthi (15° 33' N: 77° 56' E), Kurnool District, Andhra Pradesh, has found a dyke cutting across the Archæan-Cuddapah boundary, and intruding into the Gulcheru conglomerate (Vijayam, 1965).

In an area 3 miles north-east of Veldurthi a dolerite dyke is cutting across the Gulcheru conglomerate. It has a width of about 50 feet and runs east-west. To the west, it is covered by talus on the steep slopes of the hill but is exposed again at the foot of the hill in granite for about 200 feet and then covered by soil. To the east it is found intruding into the Gulcheru quartzite for about  $\frac{1}{2}$  mile. Further east the dyke and the Gulcheru quartzites are overlain by the younger Banganapalli intraformational conglomerate and sandstones. Where the dyke has intruded the conglomerate, it has assimilated, altered and even digested part of the matrix and sometimes pebbles. Such alteration increases towards the centre from the margins. Layering of mafic material inside the conglomerate bed with alternating pebble horizon can be seen. The pebbles have better shape, matrix and less altered at the margins compared to the smaller and poorly shaped pebbles and more altered matrix. A similar dyke intrusion into Gulcheru conglomerate is found 6 miles east of Kurnool, on Kurnool-Nandikotkur Road.

Where the dyke has intruded into conglomerate the hybrid rock produced has deuteric minerals apart from pyroxene and plagioclase. These alterations were probably due to the contact metamorphism of dyke into the sediment.

An igneous intrusion which intrudes into Vempalles as a sill might have cut through the older Gulcheru conglomerate and quartzites after cutting through the basement granites. It is likely that before or contemporaneous with the epeirogenic activity due to which Cuddapah

sediments were uplifted, there was a period of igneous activity. The location reported here may be one of those channels through which the basic magma has been pushed up, forming a dyke which opened up into the Vempalle dolomites as a sill taking the advantage of faults. In the Vempalle dolomites due to hydrothermal reaction of sill intrusion, serpentine, steatite and asbestos were formed which can be seen about 2 miles north-east of the location where dyke intrudes into the conglomerates.

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Geology Department, B. E. VIJAYAM.  
Osmania University,  
Hyderabad-7 (A.P.), October 3, 1967.

1. King, W., *Kadapa and Karnul Formations in the Madras Presidency, G.S.I. Memoir No. VIII.*
2. Pascoe, E. H., *A Manual of the Geology of India and Burma*, p. 231.
3. Vijayam, B. E., "Sedimentation in the upper proterozoic near Kurnool," *Ph.D. Thesis*, (Unpublished).

**STUDY OF ZIRCON CONCENTRATES  
FROM THE ALMORA GRANITE,  
KUMAON HIMALAYAS**

ZIRCON concentrates from the Almora Granite, Kumaon Himalayas, have been studied. These were obtained from the - 70 + 150 mesh fraction of crushed rock after concentration with bromoform and isodynamic separator. Earlier, thin section study had indicated that the zircon is preferentially concentrated in biotite.

The zircons are colourless to pale yellowish, with dust like and elongated to rounded inclusions. They occur mainly in the following two habits though transitional types are also present:

- (i) As elongated crystals consisting of prism with sharply terminated pyramids (Fig. 1 a, b).
- (ii) As stout crystals with dominantly pyramidal form (Fig. 1 c, e).

The crystals vary in length from 0.040 mm. to 0.270 mm. The elongation ratio, which is dependent on the relative development of the prism and pyramid faces, varies from 1:1 to 3.5:1.

The crystals are predominantly euhedral though slight rounding of the crystal edges due

to magnetic corrosion is commonly observed. In extreme cases the corrosion of the stout, dominantly pyramidal type of zircon, gives rounded grains. That this rounding is not of sedimentary origin is clear from the fact that while some parts of the crystals show extreme rounding, in other parts crystal outline is clearly observed (Fig. 1 e). In the case of the elongated crystals overgrowths and zoning are commonly seen (Fig. 1 a, b). Crystal aggregates are not uncommon (Fig. 1 d).

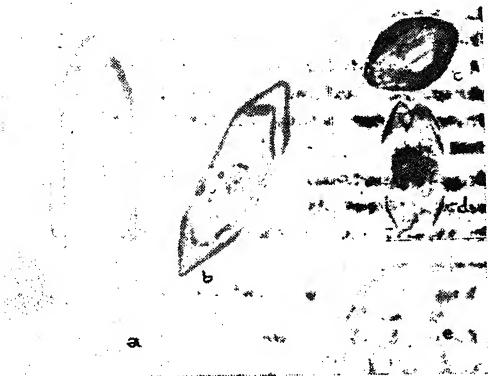


FIG. 1 (a-e). Zircons from the Almora Granite (Magnification: a,  $\times 280$ ; b-e,  $\times 140$ ).

The euhedral nature of the crystals and their preferential concentration in biotite indicates that the Almora Granite is of magmatic origin.<sup>1</sup> This conclusion has been supported by the study of perthites and plagioclases from the granite.<sup>2</sup> The presence of two types of zircons suggests fluctuation in physico-chemical conditions during crystallisation. The stout, dominantly pyramidal crystals which at times show a high degree of corrosion, apparently developed during the first phase of magmatic crystallisation. With subsequent increase in the temperature they were resorbed.<sup>3</sup> The dominantly prismatic type with higher elongation ratio most probably crystallised from the latter, more hydrous phase.<sup>4</sup>

Department of Geology, K. B. POWAR.  
Banaras Hindu University,  
Varanasi-5, September 4, 1967.

1. Schermerhorn, L. J. G., *Amer. Journ. Sci.*, 1956 **254**, 329.
2. Powar, K. B., *Unpublished Ph.D. Thesis*, B.H.U. 1966.
3. Spotts, J. H., *Bull. Geol. Soc. Amer.*, 1962, **73**, 1221.
4. Mackie, W., *Trans. Edn. Geol. Soc.*, 1928, **12**, 22.

## OCCURRENCE OF FRANKLINITE IN MANGANESE DEPOSITS OF KODURU

FRANKLINITE occurs in the manganese pit 19 of Koduru of Srikakulam District of Andhra Pradesh, India. This is the first report on this mineral from manganese deposits of India.

Franklinite is granular, 1 to 3 cm., and sub-metallic. When crystalline, it shows octahedral faces. It is feebly magnetic. The specific gravity is 4.85, different from that of the magnetite and Jocabite. It is found in intimate association with yellow ochre and lithomarge. A coarse variety is observed in dump of Garividi.

The franklinite receives good polish. The colour in reflected light is grey with deep olive tint. It is non-pleochroic and isotropic. Along the cleavage directions one finds lamellæ of hausmannite. The hardness and reflectivity of franklinite are similar to those of magnetite. Table I gives the X-ray data with Fe K $\alpha$  radiation carried out by Eveready Battery Co., London. The mineral is franklinite as read from the "X-ray diffraction Key to the manganese oxide minerals", prepared by Tauber.<sup>6</sup>

TABLE I

"D" spacings of the strongest lines	Relative intensities
2.55	100
3.00	41
4.50	30
2.12	26
1.63	26

A thermo-gravimetric analysis carried out on this mineral showed very small positive and negative weight changes over the range 20-1000° C.

The manganese forms 17% and there is a trace of insoluble residue left over in HCl/HNO<sub>3</sub>.

Table II gives the results of etching on franklinite. The etch behaviour is similar to that of franklinite described by Utyenbogaardt<sup>7</sup> and Ramdohr.<sup>3</sup>

TABLE II

Reagent	Franklinite
HCl (1 : 1)	Negative
HNO <sub>3</sub> (1 : 1)	Negative
Sn Cl <sub>2</sub>	Almost negative, slight change in colouration to brown after two minutes
Aqua-regia	Negative. The drop of the reagent turns yellow
HF	Almost negative. Slight tarnishing and the hausmannite lamellæ are clearly seen

Supria Roy<sup>4</sup> reported three types of Jacob-sites from this area: (1) Homogenous Jacob-site, (2) Jacobsite with Hausmannite and (3) Rose brown Jacobsite, with cell dimensions of  $a = 8.506 \text{ \AA}$ ,  $8.483 \text{ \AA}$ , and  $8.410 \text{ \AA}$ , respectively. The franklinite now examined is deep olive green with lamellar hausmannite, and the cell dimension is,  $a = 8.392 \pm 0.001 \text{ \AA}$ .

The spectrographic and chemical analysis of manganese ore of Koduru by Krishna Rao,<sup>2</sup> Roy<sup>5</sup> and Fermor<sup>1</sup> show some amount of zinc in Vredenburgite and pyrolusite. Such zinc can be said to be due to the alteration of franklinite in the area. Franklinite has been formed along with other manganese minerals by metamorphism of original iron, manganese and zinc hydroxides.

Geology Department. J. S. R. KRISHNA RAO.  
Andhra University,  
Waltair, October 3, 1967.

1. Fermor, L. L., *Manganese Ore Deposits of India*, Part I. *Introduction and Mineralogy*, 1909, p. 81.
2. Krishna Rao, J. S. R., *J. Sci. and Ind. Res.*, 1960, **19B** (7), 239.
3. Ramdohr, P., *Die Ersmineeralien und Ihre Verwachsungen*, 1960.
4. Supriya Roy, *Nature*, 1959, **183**, May 2, 1256.
5. —, *Syngenetic Manganese Formations of India*, 1966, p. 56.
6. Tauber, J. A., *X-ray Diffraction Key to the Manganese Oxide Minerals*, E. J. Lavino and Co., Three Penn Center, Plaza, Philadelphia, Penn, U.S.A., 1964.
7. Utyenbogaardt, W., *Tables for Microscopic Observation of Ore Minerals*, 1951, p. 182.

#### A NOTE ON THE TERTIARY CLAYS IN BIRBHUM DISTRICT, WEST BENGAL\*

SEDIMENTARY clay beds have been recorded in Maldihi, Puratangram, Ranipur, Makhdumnagar, Digalgram, Supalkuri, Kharbona, Chaknurai and Dhanmara areas, to the north of Suri in the Birbhum District, West Bengal. In recent years the Geological Survey of India carried out exploratory drilling proving the nature and extent of clay deposits. The clays are white to grey coloured with stains of yellow, pink and violet and are plastic in nature. They are intercalated and interbedded with loose and friable sandstone and the sequence is found to vary from 20 metres to as much as 60 metres. The beds are covered by laterite and alluvium.

The clay beds overlie the Archæan metamorphics to the south of the Dwarka river, while to the north, Rajmahal Traps from the basement. From the field relations, it is deduced that the clay deposits are of post-Trappean age.

Dark clay samples were selected from bore holes drilled in the above areas and were studied for their pollen and spores. Polycolpate pollen, characteristic of the Lower Eocene and other porate and colporate pollen with pteridophytic spores are present. The pollen grains belong to the families Palmæ, Magnoliaceæ, Betulaceæ, Aceraceæ, Fagaceæ and Aquifoliaceæ. Trilete spores belonging to the families Schizaceæ, Parkeriaceæ and Cyatheaceæ are identified. Conifer pollen grains constitute a low percentage in the assemblage. The presence of Hystrichospherids indicates lacustrine or lagoonic conditions of environment during deposition. The palynological data of the samples indicate a Lower Tertiary age to the clay beds.

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#### AN INCIDENCE OF VERY HIGH PHOSPHATE CONCENTRATIONS IN THE WATERS AROUND ANDAMAN ISLANDS

In the course of our investigations on the distribution of phosphate in the Bay of Bengal and the Andaman Sea during the Cruises of INS Kistna in September, 1963 as part of the Indian Programme of International Indian Ocean Expedition, we encountered abnormally high concentrations of inorganic phosphates in the samples collected from the vicinity of the Andamans. The location of INS Kistna stations at which we detected high values of phosphates is given in the figure (Fig. 1). The samples for analysis were obtained from all standard depths from the surface down to 200 metres and estimation of phosphates was done following the method of Robinson and Thompson (1948).<sup>1</sup>

An examination of the results obtained shows the following features, viz., (1) Concentration of phosphates exceeding  $12 \mu\text{g at/L}$  were found at all the depths at the stations close to the coast (315 to 318). At other stations

these high concentrations were confined to only a few depths at random. (2) The vertical distribution of phosphates in the 200 metre column does not appear to correspond to any regular accepted pattern. (3) All the samples having the abnormally high phosphate concentration were found to be highly turbid and having milky-white appearance. It was suspected that the turbidity might be due to the presence of carbonate but qualitative tests proved negative.

are subjected to the effect of rough sea leading to the formation of the large amount of coral detritus. Nair *et al.* (1966)<sup>3</sup> in the course of work in Andria Bank region of the Arabian Sea which also contains several coral banks and islands have come across waters of abnormally high concentration of phosphates. It is therefore suggested that there is some kind of association between the occurrence of coral banks and occurrence of water with abnormal concentration of phosphates. Examin-

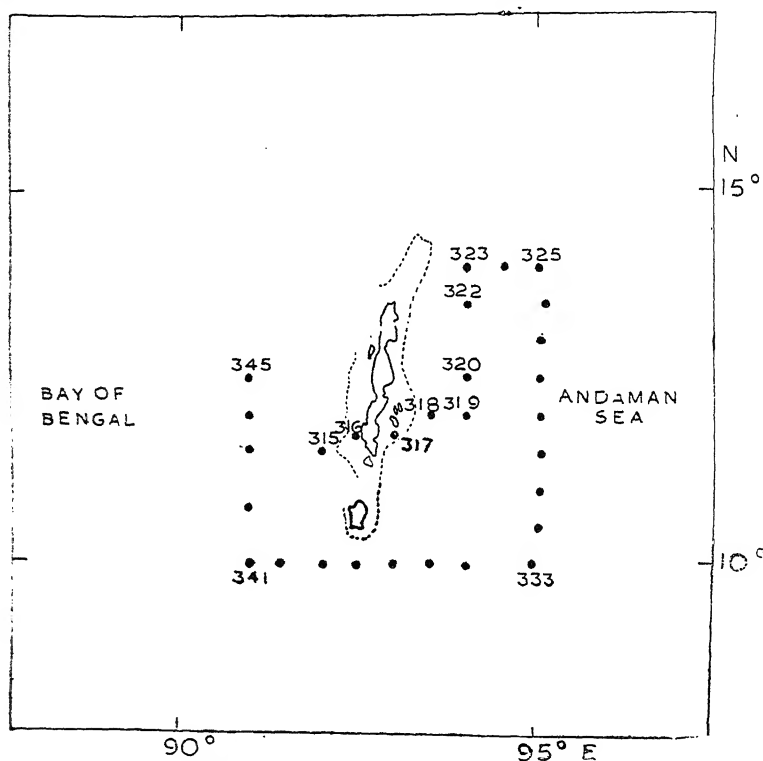


FIG. 1. Map showing INS *Aistna* station locations.

Since this is the first time this type of studies were carried out in this region any explanation for this phenomenon at this stage could at best be considered as purely tentative.

A detailed examination of the general hydrographical features of the Andaman Nicobar regions might however provide some answer to this very interesting phenomenon. We have been examining the possible sources of this abnormally high phosphate waters. It is found that along the western edge of the continental shelf of Andaman Islands which is wider than the eastern shelf, there are a number of coral banks and as stated by Sewell (1925)<sup>2</sup> during the south-west monsoon period these coral banks

ing further about the other chemical and bio-chemical factors it has been found (Zernova and Ivannov, 1964)<sup>4</sup> that Andaman Sea is a region of highest production of phytoplankton in the northern Indian Ocean. Tipper (1911)<sup>5</sup> had reported about the occurrence of phosphatic nodules in the shelf regions around Andaman Islands. Sen Gupta and Pylee (1966)<sup>6</sup> have reported a very high specific alkalinity of these waters indicating high calcium content and this factor combined with high phosphate content might explain the turbidity of these waters presumably due to the precipitation of the calcium phosphate. That high calcium content may stimulate the precipitation

of phosphorous has also been reported by Bhushinski (1964).<sup>7</sup> It is also possible, as indicated by Emery and Dietz (1950)<sup>8</sup> as a result of their investigations off the California coast, that during certain times of the year the product of calcium and phosphate ions in these waters may exceed the solubility product of tricalcium phosphate thereby giving rise to precipitation of these compounds. We do not have sufficient data to support this view but the possibility of such a precipitation is not ruled out. It is further suggested that more detailed investigations in this area would help in a better understanding of this phenomenon.

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National Institute of Oceanography,  
Ernakulum,  
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P. S. N. MURTY.  
V. N. SANKARANARAYANAN.

1. Robinson, R. J. and Thompson, T. G., *J. Mar. Res.*, 1948, **7**, 33.
2. Sewell, R. B. S., *Memoir, Asia. Soc. Beng.*, 1925, **9**, 1.
3. Nair, K. V. K., Bhattathiri, P. M. A. and Chapgar, B. F., *Angria Bank Expedition*, Report No. AEEI/HP/PM3, Atomic Energy Establishment, Trombay, 1966, p. 1.
4. Zernova, V. V. and Ivannov, Ju. A., *Trud. Inst. Okeanol.*, 1964, **64**, 265.
5. Tipper, G. H., *Memoir Geol. Surv., India*, 1911, **35**.
6. Sen Gupta, R. and Abraham Pylee, Paper presented at the *Second Int. Oceanogr. Cong., Moscow*, 1966.
7. Bhushinski, G. I., *Developments in Sedimentology*, 1964, **1**, 62.
8. Emery, K. O. and Dietz, S., *Cal. Jour. Mines. Geol.*, 1950, **46**, 7.

# ON ANOMALOUS EMISSION OF ECHINOSTOME LARVAL STAGES AND THE INTRAREDIAL ENCYSTMENT OF CERCARIAE IN THE SNAIL *PILA GLOBOSA* SWAINSON

THERE appears to have been no previous report of cercarial infection in the apple-snail *Pila globosa* from India.<sup>1</sup> We have, however, observed that the snail collected locally harboured stages of a thirty-three spined echinostome (Fig. 1).

The cercaria like any other echinostome displays a well-marked collar but the minute spines are apparently indistinguishable. In the metacercaria the spines could be seen and

counted clearly. An interesting but not an unusual phenomenon in some echinostomes is the precocious encystment of some cercariae in the rediae in the snail host itself. Another feature observed was the escape of cercariae and metacercariae through the faecal pellets of the host (Fig. 2). Such anomalous emission of larval stages of *Fascioloides magna* has been reported by Campbell and Todd<sup>2</sup> in an experimental infection of the snail, *Stagnicola reflexa*.



FIG. 1. Echinostome cercaria from the snail *Pila globosa*.

It has been pointed out that this condition may be due to the unsuitability of the host as well as a result of heavy infection. Obviously the larvae find their way out through perforations in the gut of the host. In the present case a similar situation like the one reported by Campbell and Todd could be envisaged.

It is well known that echinostomes lack host specificity both at the intermediate host and definitive host levels.<sup>3-4</sup> Thus the precocious encystment of cercariae in rediae although rare in the Digenea as a whole, appears to be common at least in some echinostomes which infect abnormal hosts. In recent years Lie and Umathevy<sup>5-6</sup> recorded intraredial metacercariae in *Echinostoma audyi* and *Echinoparyphium dunni* and Lie and Basch<sup>7</sup> encountered them in *Echinostoma Barbosai*. Chernin<sup>8</sup> reported on metacercariae within echinostome rediae that have been transplanted into *Australorbis*

*glabratus* (recipient snail) from *Physa heterostrophæ* (donor snail). About 50% of the transplanted rediæ contained one to three metacercariæ. Quoting Lie's personal communication "intraredial encystment seems to occur mainly in echinostome larvae which are not healthy for various reasons," Chernin concluded that his findings also support this view.

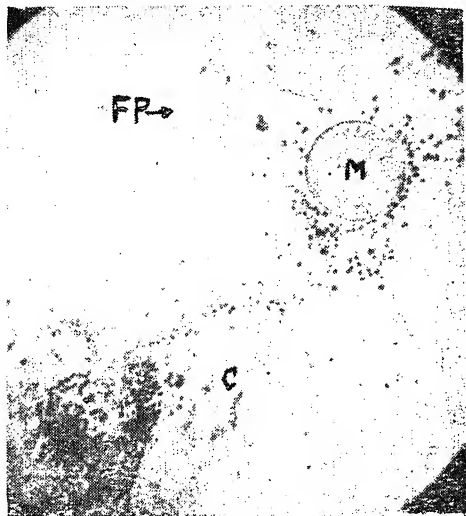


FIG. 2. Faecal pellet (FP) of *Pila globosa* containing cercaria (C) and a metacercaria (M).

In the present case the anomalous emission of rediæ and cercariæ through gut in faecal pellets points to the fact that *Pila globosa* may not be a suitable host for this species and that heavy infections may also lead to such a condition. Encystment of cercariæ within rediæ therefore seems to be a logical outcome of these abnormalities. However, the capacities for quick encystment may be an additional contributory cause.

In a study on the life-history of *Echinostoma nudicaudatum* the problem of intraredial encystment has been dealt with by Nasir.<sup>9</sup> He stated that it is very unlikely that encystment would take place while the cercaria is in the redia. According to him the cercaria must first leave the snail, spend an active free swimming period and reenter the snail for encystment and that "very occasionally it penetrates a redia before encysting". Moreover it was reported that immature cercariæ of *E. nudicaudatum* leave the rediæ and complete development during the extraredial phase in the tissues of the snail. There may be such interesting variations in the development of echinostome cercariæ. For

instance Etges<sup>10</sup> reported that in the echinostome *Cercaria reynoldi* the body reaches full size and development but the tail lies in a collapsed condition in the redia. It is only in the extraredial phase in the snail tissues that the tail reaches full development. However, in the present echinostome it has been found that both body and tail reach full development before leaving the redia. There is therefore nothing precluding precocious encystment to occur without cercariæ ever leaving the rediæ. It is therefore felt unnecessary to postulate that the cercariæ from *P. globosa* may reenter the snail and then the redia for encystment.

Department of Zoology, P. N. GANAPATI.  
Andhra University, K. HANUMANTHA RAO.  
Waltair, December 1, 1967.

1. Sewell, R. B. S., *Ind. J. Med. Res.*, 1922, **10**, 370.
2. Campbell, W. C. and Tood, A. C., *Trans. Amer. Micr. Soc.*, 1956, **65**, 241.
3. Beaver, P. C., *Illinois Biol. Mon.*, 1937, **15**, 29.
4. Hanumantha Rao, K., *Parasitology*, 1963, **53**, 1.
5. Lie, K. J. and Umathevy, T., *J. Parasit.*, 1965, **51**, 781.
6. — and —, *Ibid.*, 1965, **51**, 793.
7. — and Basch, P. F., *Ibid.*, 1966, **52**, 1052.
8. Chernin, E., *Ibid.*, 1966, **53**, 219.
9. Nasir, P., *Proc. Helminth. Soc.*, Washington, 1962, **29**, 115.
10. Etges, T., *Trans. Amer. Micr. Soc.*, 1961, **80**, 221.

#### BREEDING BEHAVIOUR OF MONOSOMICS IN COMMON WHEAT

ALL the 21 monosomic lines of the wheat variety Chinese Spring, developed by Dr. E. R. Sears, are being maintained at the Division of Genetics, Indian Agricultural Research Institute, New Delhi. These monosomic lines are utilised for genetic analyses.<sup>1,2</sup>

The breeding behaviour of monosomic lines has been given in Table I for a period of six years. It is seen from the table that the frequency of double monosomics (19 II + 2 I) that has been recorded from among the progenies of monosomic plants (20 II + 1 I) is very high as compared with the reports available in the literature.

Person<sup>3</sup> in a study of 225 monosomic progenies found only one double monosomic plant (0.4%), and McGinnis and Campbell<sup>4</sup> have also reported a similarly low frequency of double monosomics that were observed by them. As compared with this the observed mean frequency of 1.9% double monosomics in the present study is significantly higher and rather corresponds to the expected frequency of nullisomics (20 II) that are expected on selfing monosomics. In

fact in the year 1964 as high a frequency as 4.8 has been recorded for double monosomics. The complete absence of nullisomics in the present report is due to the fact that only healthy plants are analysed cytologically so that the monosomic plants which are identified can be used for the purpose of maintenance and crossing work.

No definite explanation can be offered to explain this unusually high rate of transmission of double monosomics. It is possible that differences in temperatures existing at different locations may be responsible for this as has been reported by Riley<sup>5</sup> with respect to chromosome pairing in nulli-5 D tetra-5 B material grown at different temperatures. As a high frequency of double monosomics and other aneuploids may permit "univalent shift" to occur,<sup>4</sup> a rigid cytological check is essential on the monosomic plants used in selfing or crossing in order to maintain the identity and purity of the monosomic lines.

TABLE I  
Cytological analysis of the progenies of monosomic plants

Year	Disomes	Monosomes	Double monosomes	Other aneuploids
1962	40 (51.2)	37 (47.4)	Nil	1 (1.2)
1963	23 (50.0)	21 (45.5)	2 (4.3)	Nil
1964	38 (36.5)	61 (58.6)	5 (4.8)	Nil
1965	63 (47.7)	62 (46.9)	4 (3.0)	3 (2.2)
1966	53 (53.0)	45 (45.0)	1 (1.0)	1 (1.0)
1967	62 (40.7)	86 (56.5)	Nil	4 (2.6)
Total	279 (45.6)	312 (51.0)	12 (1.9)	9 (1.5)

Frequencies in per cent. are given in parentheses.

The authors are grateful to Dr. M. S. Swaminathan, Director, for his keen interest in this work.

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Institute, Delhi-12,  
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R. N. SAWHNEY.

1. Joshi, B. C. and Kumar, S., *Int. J. Genet.*, 1967 **27**, 86.
2. — and Singh, D., *Ibid.* (In press).
3. McGinnis, R. C. and Campbell, A. B. *Can. J. Genet. Cytol.*, 1960, **2**, 47.
4. Person, C., *Can. J. Bot.*, 1956, **34**, 60
5. Riley, R., *Chromosomes Today*, Oliver and Boyd, Edinburgh and London, 1966.

## NITROGEN FIXATION BY THE BLUE-GREEN ALGA *TRICHODESMIUM ERYTHRAEUM* (EHR)

ALLISON *et al.*,<sup>1</sup> Fogg,<sup>2</sup> Magee and Burris<sup>3</sup> and Venkatraman,<sup>4</sup> have shown that atmospheric nitrogen is fixed by the non-marine species of blue-green algæ, *Nostoc* and *Anabaena*. Dugdale *et al.*,<sup>5-6</sup> using N<sup>15</sup>, investigated the nitrogen fixing rates in the marine blue-green alga *Trichodesmium* sp., in the natural environment. The present note relates to nitrogen fixation by *Trichodesmium erythraeum* in axenic cultures. As reported elsewhere,<sup>8-10</sup> pure cultures of the species *Trichodesmium erythraeum* have been maintained in our laboratory for over two and a half years.

To determine whether *Trichodesmium erythraeum* is able to fix atmospheric nitrogen, the following procedure was adopted. A portion of the algal material from fresh subculture was grown in each of the following three media omitting molybdenum and iron as suggested by Allen<sup>7</sup>: (1) nitrogen-free media; (2) media containing KNO<sub>3</sub> (1.6 gm./l.); (3) media containing NH<sub>4</sub>Cl (1.6 gm./l.). The gas washing system of aeration apparatus suggested by Fogg<sup>2</sup> was adopted. Nitrogen estimation was done by the conventional microkjeldahl method.

The results of the analysis of the culture grown in nitrogen-free media and in media supplied with KNO<sub>3</sub> and NH<sub>4</sub>Cl are shown in Fig. 1. The quantity of nitrogen fixed by

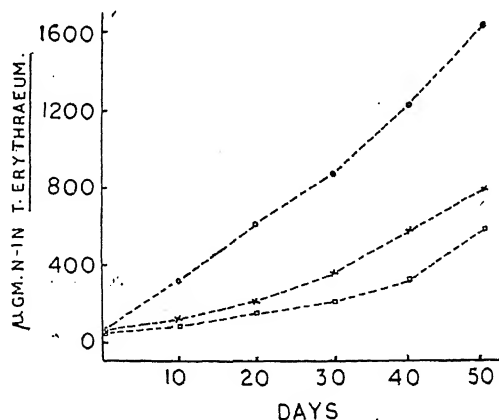


FIG. 1. Nitrogen fixation by *T. erythraeum*.  
○—○ Nitrogen free media.  
×—× Media with KNO<sub>3</sub>.  
□—□ Media with NH<sub>4</sub>Cl.

*Trichodesmium erythraeum* is very marked. In nitrogen-free media, the fixation of nitrogen by *T. erythraeum* increases very rapidly. Starting with an initial value of 56 µg./gm. it increases

to 1640  $\mu\text{g./gm.}$  in 50 days, whereas in media with  $\text{KNO}_3$  it increases from 54  $\mu\text{g./gm.}$  to 780  $\mu\text{g./gm.}$  and in media with  $\text{NH}_4\text{Cl}$  it increases from 52  $\mu\text{g./gm.}$  to 580  $\mu\text{g./gm.}$  in 50 days. The average rates of increase of nitrogen content of the *T. erythræum* per day during successive ten-day periods in different media are shown in Table I.

TABLE I

Days	Nitrogen-free media $\mu\text{g./gm.}$	Media with $\text{KNO}_3$ $\mu\text{g./gm.}$	Media with $\text{NH}_4\text{Cl}$ $\mu\text{g./gm.}$
1 to 10	.65	.12	.09
11 to 20	.73	.23	.12
21 to 30	.78	.32	.14
31 to 40	.87	.55	.23
41 to 50	1.0	.84	.58

The results clearly indicate that *T. erythræum* can fix free nitrogen. The fixation of combined nitrogen is inhibited as in freshwater blue-green algae investigated so far. It will also be seen that the rate of fixation increases with the duration of the experiment.

Our thanks are due to Prof. R. V. Seshaiya, Director, for suggesting the problem and guidance, and to the University Grants Commission for the award of Research Fellowships. Centre for Advanced Study V. D. RAMAMURTHY.  
in Marine Biology, S. KRISHNAMURTHY.  
Porto Novo (S. India), October 19, 1967.

1. Allison, F. E., Hoover, S. R. and Morris, H. J., *Bet. Gaz.*, 1937, 98, 433.
2. Fogg, G. E., *J. Exp. Biol.*, 1942, 19, 78.
3. Magee, W. E. and Burris, R. H., *Amer. J. Bot.*, 1954, 41, 777.
4. Venkatraman, G. S., *Proc. Symp. Algology (ICAR)*, 1960, p. 119.
5. Dugdale, R. C., Menzil, D. W. and Ryther, J. H., *Deep. Sea Res.*, 1961, 7, 298.
6. — and Goering, J. J., *Limnol. & Oceanogr.*, 1964, 4, 507.
7. Allen, M. B., *Symp. Marine Microbiol.*, Ed. C. H. Oppenheimer, Charles, C. Thomas, 1963, 3, 85.
8. Ramamurthy, V. D. and Seshadri, R., *Proc. Ind. Acad. Sci.*, 1966, 64 (3), 146.
9. — and Krishnamurthy, S., *Ibid.*, 1967, 65 (2), 43.
10. — and —, *Curr. Sci.*, 1967, 36 (19), 524.

#### OPISTHORCHIS NOVERCA BRAUN, 1902 IN THE PANCREAS OF DOMESTIC PIG (*SUS SCROFA DOMESTICA*) IN BIHAR

OPISTHORCHID trematodes have been reported from the liver of Indian dogs, among others, by Bhalerao<sup>3</sup> (*O. noverca*; *O. noverca* var. *orbiculata* and *O. noverca* var. *lobata*), Sami<sup>9</sup> (*O. caninum*), Mudaliar<sup>7</sup> (*O. noverca*), Bhatia et al.<sup>4</sup> (*Paropisthorchis caninus*—also from cats) and

Gupta and Pande<sup>6</sup> (*O. caninus*). *O. felineus* and *O. tenuicollis* have been reported respectively by Patnaik<sup>8</sup> and Chakravarty and Sinha<sup>5</sup> from cats. The only record of an opisthorchid trematode, *O. noverca* (*O. noverca* var. *lobata* and *O. noverca* var. *orbiculata*) from the domestic pig in India appears to have been made by Bhalerao<sup>3</sup> from the bile ducts. He mentions only 5% of the pigs to be infected.

Strangely enough, during an investigation, in which 150 *deshi* domestic pigs were examined postmortem from the Gangetic plains of Bihar at Patna for the helminth parasites, 107 pigs were found to carry the opisthorchid fluke in the pancreatic ducts alone. The infection rate thus works out to be 71% and on no occasion, the fluke was recovered from liver, bile ducts or gall bladder. On morphological study of several stained specimens, they were identified as *O. noverca* Braun, 1902. This appears, therefore, to be the first record of this species from the pancreas of pigs.

It is also interesting to find such a high incidence in pigs of Bihar, when it was not reported in surveys for the pig-parasites from other parts of India (Alwar<sup>2</sup> from Madras and Ahluwalia<sup>1</sup> from U.P.) except from Bengal where Bhalerao<sup>3</sup> mentions the incidence to be only 5%. The unusual site of its occurrence in the pancreas alone with its absence from the bile ducts or gall bladder, a more common predilection site in other host animals may have been a reason for being overlooked in other surveys.

The pancreas harbouring the flukes did not show any apparent gross lesion. In heavy infections, most part of the ductal system was filled with the parasite. On histopathological examination different degrees of changes were observed in ductal and periductal tissues. The most conspicuous change in the pancreatic duct containing the fluke was extensive proliferation of ductal epithelium with the formation of complex folds or crypts projecting into the lumen (Fig. 1 A). Epithelial disquamation was evident at some places. The epithelial lining in most of the sections showed marked increase in the secreting cells, virtually distended with their secretion (Fig. 2 A). Below the epithelium in lamina propria was infiltration of mostly lymphocytes and a few eosinophils (Figs. 1 C and 2 B). Encircling outside the epithelium was pronounced periductal fibrosis (Fig. 1 B) in the form of a fibrous band. Thus the picture presented was that of chronic proliferative inflammation.



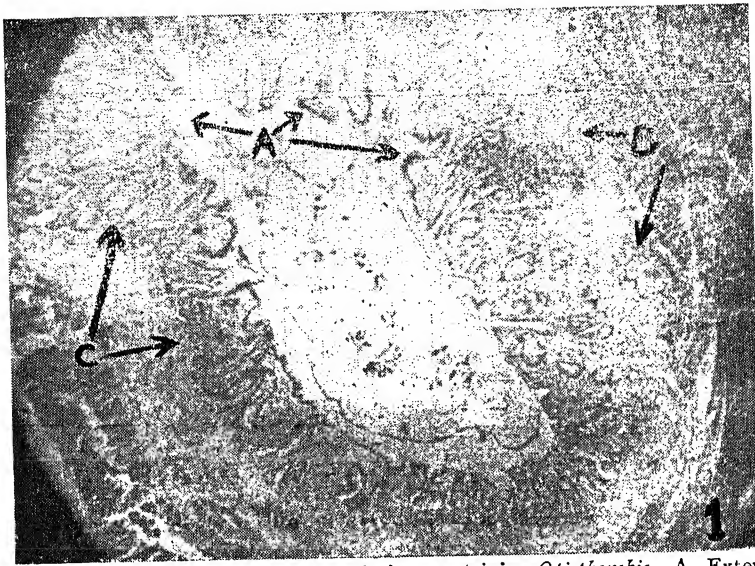


FIG. 1. Photomicrograph of section of pancreatic duct containing *Opisthorchis*. A, Extensive proliferation of ductal epithelium forming folds. B, Periepipithelial fibrous band. C, Cellular infiltration in lamina propria.



FIG. 2. Photomicrograph of a section of pig pancreatic duct showing (A) increase in the number of engorged secreting cells and (B) infiltration of lymphocytes and eosinophils in lamina propria.

In some of the sections showing early infection, the proliferative changes in epithelial lining as well as periductal fibrosis was less marked with more of cellular infiltration in tunica propria.

The author expresses his gratitude to Dr. A. K. Varma, under whose supervision this investigation was carried out.

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1. Ahluwalia, S. S., *Ind. J. Vet. Sci.*, 1959, **29**, 100.
2. Alwar, V. S., *Ind. Vet. J.*, 1958, **35**, 112.
3. Bhalerao, G. D., *Rec. Ind. Mus.*, 1931, **33**, 475.
4. Bhatia, B. B., Sood, S. M. and Pande, B. P., *Ind. Vet. J.*, 1959, **36**, 528.
5. Chakravarty, M. and Sinha, P. K., *Ibid.*, 1960, **33**, 17.
6. Gupta, V. P. and Pande, B. P., *J. Helminth.*, 1963, **37**, 291.
7. Mudaliar, S. V., *Ind. Vet. J.*, 1943, **19**, 289.
8. Patnaik, B., *Ibid.*, 1959, **36**, 595.
9. Sami, M. A., *Ind. Med. Gaz.*, 1938, **73**, 93.

ON THE OCCURRENCE OF THE  
SIPHONOPHORE *PHYSALIA PHYSALIS*  
L., AND THE LABRID FISH  
*LABROIDES DIMIDIATUS*  
(CUV. ET VAL.)  
IN THE MINICOY ISLAND  
(ARABIAN SEA) AREA

DURING the month of June 1965 a large number of *Physalia physalis* L. were observed washed ashore on Minicoy Island and its fringing reef. The specimens were of fairly uniform size: the pneumatophore measuring 44 mm. in length and 19 mm. in height. The specimens collected were all left-handed; Hardy<sup>1</sup> (quoting Mr. Mackie) mentions that left-handed or right-handed shoals of *Physalia* are encountered according to the prevailing set of winds, thus explaining the preponderance of one or the other kind in single catches. The present material appears to be wholly of one kind, viz., left-handed; and it appeared probable that complete sorting out of the two kinds must have occurred in the open sea, before the shoal stranded.

While examining a catch of baitfishes (used by the local fishermen to 'chum' tuna fishes), gathered by diving among the coral-heads in the lagoon, I came across a few specimens of the labrid fish *Labroides dimidiatus* (Cuv. et Val.). The photograph shows a specimen of

while De Beaufort<sup>4</sup> records its presence in the Maldive Islands, in addition.

Both *Physalia physalis* L. and *Labroides dimidiatus* are being recorded for the first time from the Minicoy Island area (Long. 73° 0' E and 73° 4' E; Lat. 8° 15' N and 8° 20' N) in the Arabian Sea.

Central Marine

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1. Hardy, A. C., *The Open Sea: The World of Plankton*. Collins, Lond., 1956, pp. xv + 355 (see p. 121).
2. Smith, J. L. B., *The Sea Fishes of Southern Africa*. Central News Agency, South Africa, 1953, pp. xvi + 564 (see p. 291).
3. Day, F., *The Fishes of India*, 2 Vols., Wm. Dawson & Sons, Lond., 1958, pp. viii + 778, (see p. 393).
4. De Beaufort, L. F., *The Fishes of the Indo-Australian Archipelago*, Brill, Leiden, 1940, 8, pp. xv + 508 (see pp. 147-150).

STOMATAL ONTOGENY IN *HABENARIA*  
*MARGINATA* COLEB.

ACCORDING to Stebbins and Khush<sup>2</sup> stomata in the members of the family Orchidaceae are devoid of subsidiary cells. Although this is the only report on the stomata of Orchidaceae, it does not describe the ontogeny of stomata. The present study on the leaves of *Habenaria marginata* Coleb. was undertaken to check if anomocytic stomata follow a haplocheilic mode of ontogeny. The leaves are hypostomatic.

Stomatal meristemoid is more or less squarish with rounded angles scattered irregularly all over the leaf epidermis (Fig. 1). Occasionally they occur in groups (Fig. 1). The meristemoid becomes distinguishable from the epidermal cells by a prominent nucleus and a dense cytoplasm. It directly becomes a guard mother cell without cutting off any subsidiary cells. It divides by a vertical wall forming two equal guard cells (Fig. 1 b and c). The guard cells elongate in the long axis of the epidermis and form an anomocytic stomata (Fig. 1 d and e).

The occurrence of groups of 2-5 stomata is frequent (Fig. 2). In a group of 2, one of the stomata is sometimes smaller than the other (Fig. 2). Contiguous stomata have not been observed.

It is surprising that *Habenaria marginata* Coleb. a member of highly evolved family Orchidaceae shows simple ranunculaceous type of stomata.

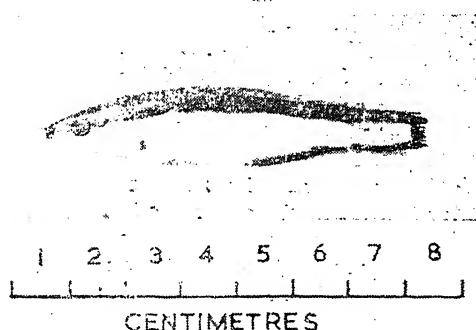
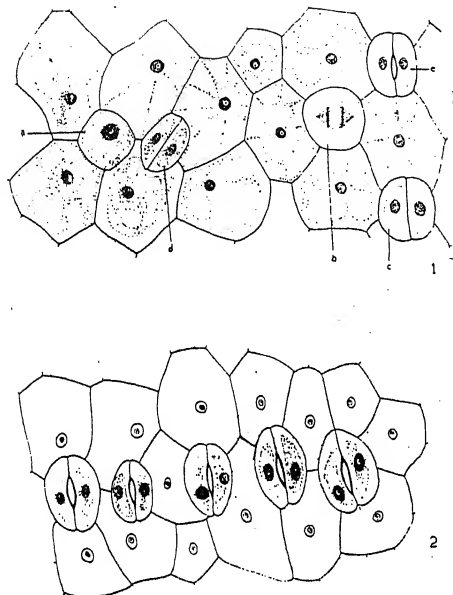


FIG. 1. *Labroides dimidiatus* (Cuv. et Val.) from Minicoy lagoon.

this species. The length (total) varies between 4 and 7 cm. Smith<sup>2</sup> gives details of the characteristics of this species which he recorded in the Southern Africa area under the generic name *Fissilabrus* Kner, 1860, though it is obvious that the generic name *Labroides* Bleeker, 1851 has priority. Day<sup>3</sup> records the distribution of this species as the Red Sea, Coromandel coast, and Andamans to the Malay Archipelago;



FIGS. 1-2. Fig. 1. Leaf epidermis showing stomatal meristemoids in different stages of development (a, stomatal meristemoid; b, same showing division; c, same after vertical division; d, primary guard cells showing elongation; e, mature anomocytic stomata). Fig. 2. Group of anomocytic stomata. Figs. 1-2,  $\times 165$ .

My sincere thanks are due to Dr. G. S. Paliwal for reading through the manuscript. My thanks are also due to Mr. C. D. Patel and Mr. S. L. Patel for collecting the material for me from Bulsar.

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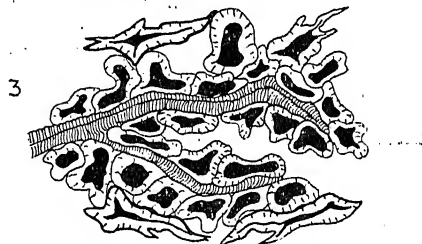
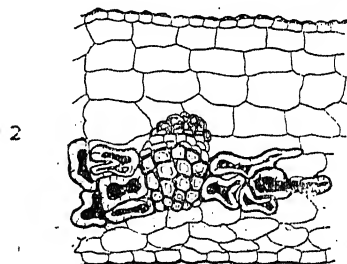
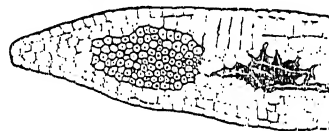
J. A. INAMDAR.

1. Santapau, H. and Kapadia, Z.. *The Orchids of Bombay*, Botanical Survey of India, Calcutta, 1964.
2. Stebbins, G. I. and Khush, G. S., *Am. J. Bot.*, 1961, 48 (1), 51.

# DISTRIBUTIONAL PATTERNS OF SCLEREIDS IN THE LEAF AND STIPULES OF *SYMINGTONIA* *POPULNEA* (R. Br. ex GRIFF.) STEEN. (HAMAMELIDACEAE)

THE presence of sclereids in various parts of the plant including the floral parts is reported by various authors. While studying the comparative morphology and ontogeny of the leaf sclereids were observed in the large coherent stipules and broad leaves of *Symingtonia populnea*. In this note their distributional patterns are described.

Preliminary studies indicate that the sclereids are distributed along the margins on either side of the midrib and the mesophyll of the lamina. The laminar sclereids exhibit two basic patterns of distribution-terminal and marginal. The terminal sclereids are commonly situated near the vein endings and they are short, polymorphic with arrested branches and show a striated cell wall and a lumen of irregular width. The marginal sclereids occur from apex towards the base in the form of regular strands along the lateral margins of the leaf. They are short, fusiform with arrested branches and firmly interlock forming a marginal strand. The occurrence of such sclereid strands close to leaf margins constitute a unique pattern so far reported for *Maba nigrescens*.<sup>1</sup> In transection each strand appears more or less oval in outline separated from the epidermal layers of cells (Fig. 1). Their disposition suggests that they protect the leaf margin.



FIGS. 1-3. Fig. 1. Transection of the leaf showing marginal strand. Fig. 2. Transection of the stipule. Fig. 3. Paradermal view of the stipule showing the close disposition of sclereids and veins,  $\times 50$  each.

Stipular sclereids are short and polymorphic and show a diffuse or restricted arrangement along the veins (Figs. 2 and 3). They have thick wall and a lumina of irregular width. The pattern of distribution shows that they afford mechanical strength to the large stipules

against shearing stresses. So far the presence of stipular sclereids of varied nature is reported in *Nymphæa odorata*,<sup>2</sup> many species of Magnoliaceae<sup>3</sup> and *Rhizophora mucronata*.<sup>4</sup>

Thanks are due to Dr. K. Subramanyam for going through this note.

Botanical Survey of India, T. ANANDA RAO.  
76, Lower Circular Road,  
Calcutta-14, October 4, 1967.

1. Rao, T. A. and Kelkar, S. S., *Sci. & Cult.*, 1950, **16**, 209.
2. Gaudet, J., *Amer. J. Bot.*, 1960, **47**, 525.
3. Tucker, S. C., *Ibid.*, 1964, **51**, 1051.
4. Shaw, J. J. and Sundarraj, K. P., *Curr. Sci.*, 1965, **34**, 155.

## SECONDARY HOST INFECTION BY AN ENTYLOMA SPECIES

*Entyloma thirumalachari* Pavgi and Singh parasitizes *Blumea oxydonta* DC., a common herbaceous monsoon weed growing on uncultivated and waste lands, bunds of cultivated fields and in shady low-lying places. Initial (primary) infection appears in early August as few white pustules on the lower leaves developing into creamy-yellowish, gall-like sori with crinkling of the lamina.<sup>2</sup> The sori mature in 6 to 7 weeks, while the lower infected leaves wither and fall over the ground. Fresh sori continue developing on the upper leaves and even in the crown until early October under favourable moisture and temperature conditions, but they are numerous and smaller in size inciting little crinkling on the leaf surface. Teliospores occupying the mesophyllar inter-spaces do not germinate *in situ* in a closed sorus and no conidiophores and conidia are found over the sorus, unlike in the species of *Entyloma* parasitic on the Compositæ in the *E. compositarum* group.<sup>3</sup> Mature teliospores of the pathogen are liberated free over the soil soon after rotting and disintegration of the withered leaf tissues, while the rain showers and heavy dew deposit occur until late in September and October respectively under the optimal temperature between 26-28° C. They are induced to germinate in the field immediately after and through October apparently without any dormancy, until the environment favours the process. The air-borne sporidia from these germinated teliospores provide inoculum for the continued infection of the young leaves. Profusion of smaller sori late in the season and germinability of freshly formed teliospores led to check on a possibility of secondary leaf infection during the season.

Healthy seedlings raised in pots in the greenhouse were inoculated in isolated sets with (a) the germinating teliospores from the withered leaves, (b) teliospores drawn from fresh mature sori and germinated on slide mounts and (c) an artificial sporidial culture of the fungus on potato dextrose agar (200 gm. peeled potato, 10 gm. dextrose, 20 gm. agar agar and 1000 ml. water adjusted to pH 6.5) medium. The inoculum smeared on the leaves was covered with moist cotton and the plants were placed under a moisture chamber for 48 hr. A set of control blanks was run with the leaves smeared with distilled water alone. Infection became discernible after 15 days in all the sets except in the control blanks, developing into small whitish pustulate sori. This observation confirmed pathogenic potential of the fungus to bring about secondary infection of the host.

Ability for secondary infection is a rare occurrence amongst the members of Tilletiaceae, except perhaps in the species of *Entyloma*<sup>1</sup> and *Tubercinia*,<sup>4</sup> though widely prevalent in the Ustilaginaceae. Development of conidial crops on aerial conidiophores emerging in dense masses through the stomates have been reported in several species of *Entyloma* especially in the *E. compositarum* group<sup>3</sup> and *E. nymphææ* (Cunn.) Setchell and E. fergussoni (Berk. and Br.) Plowright.<sup>1</sup> Obviously these conidia function in nature as the secondary inoculum for continued host infection. This report presents an experimental evidence for secondary infection through sporidia and not the conidia alone in the genus *Entyloma*.

College of Agriculture, R. A. SINGH.  
Banaras Hindu University, M. S. PAVGI.  
November 9, 1967.

1. Fischer, G. W. and Holton, C. S., *Biology and Control of the Smut Fungi*, Ronald Press Co., New York, 1957, p. 622.
2. Pavgi, M. S. and Singh, R. A., *Canad. J. Botany*, 1967, **45**, 939.
3. Savile, D. B. O., *Canad. J. Res.*, 1947, **25 C**, 105.
4. Woronin, M., "Beitrag zur Kenntniss der Ustilagineen," in A. De Bary and M. Woronin, *Abhandl. Senckenberg. Naturforsch. Ges.*, 1882, **12**, 559.

## EMBRYOLOGICAL STUDIES IN COMPOSITÆ-FLORAL MORPHOLOGY, SPOROGENESIS AND GAMETOGENESIS IN *EMILIA SONCHIFOLIA* (LINN.) DC.

THE family compositæ is of great interest embryologically. It displays interesting variations in embryo-sac development, viz., *Polygonum*, *Scilla* (*Allium*), *Peperomia*, *Drusa* and *Fritillaria* types have been found within

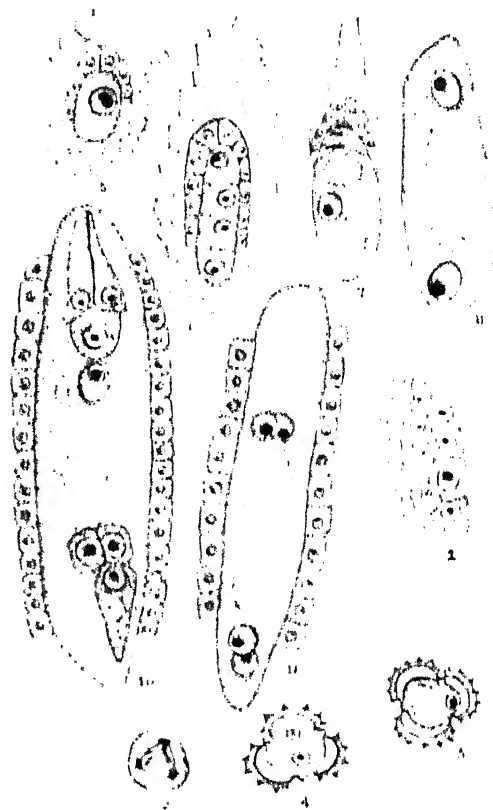
the family (Schmard, 1931). Sometimes the antipodal cells and even the synergids are haustorial in function. Synergid haustoria have been observed by G. L. Davis (1962) in *Cotula australis*. Besides this, polyembryony, parthenocarpy and apogamy are also found in some members of the family. Earlier literature has been reviewed by Sonnerup (1930), Venkateswarulu and Maheswari Devi (1955) and G. L. Davis (1964).

The present investigation deals with some aspects of floral morphology and embryology of *Emilia sonchifolia* (Lam.) DC. Material was collected round about Bangalore and the heads were fixed in F. & A. Sections of Capitula were cut at 7 to 10  $\mu$  thickness and stained with Heidenhain iron haematoxylin. Observations were also supplemented with wholemounts of pollen mother cells and pollen grains.

*Emilia sonchifolia* belongs to the tribe Senecioideae and sub tribe Eupatorieae. It is a soft-stemmed herb with purple flowers. Heads are small and number of long and few flowered. As the head is homogamous, ray florets are absent. The development of the florets in a head is almost synchronous. The capitulum is uniseriate bracteate and chabrate late. Pappus consists of capous, white, soft, minute hairs. Corolla is slender and tubular with inflated limb. The corolla lobes are very short and five in number. Achenes are small and five ribbed.

A longitudinal section of a young anther lobe shows a single layer of microspore mother cells followed by a layer of tectum, a middle layer, and endothecium and an exothecium (Fig. 1). The tapetal cells are multinucleate. When the pollen grains are mature, the inner and the radial walls of the tapetal cells dissolve and the cytoplasm flows out into the anther sac forming a typical periplasmodium. A tapetal periplasmodium has been noticed previously in *Lanunculus pinnatifidus* (Venkateswarulu and Maheswari Devi, 1955) and *Bracteantha ciliaris* (G. L. Davis, 1964). The periplasmodium gradually degenerates as the pollen grains develop and disappears in the mature anther. The endothecium shows no fibrillar thickening even at the time of pollen shedding. A similar absence of fibrillar endothecium has been reported earlier in *Lanunculus pinnatifidus* (Venkateswarulu and Maheswari Devi, 1955). The microspore mother cells undergo reduction division and give rise to tetrads of microspores, which are arranged tetrahedrally (Fig. 2). Microspores are smooth-walled when they are in tetrads. But after

their separation, the pollen grains show some small undulations which foreshadow the position of future spines. A single-nucleate pollen grain (Fig. 3) consists of thick exine ornamented with spines and a thin intine. The mature pollen grain is two-celled at the time of shedding and it is triplicate (Fig. 4).



Figs. 1-10. Fig. 1, L.S. of a young anther lobe,  $\times 666$ . Fig. 2, Arrangement of the spores during the formation of microspores to show tetrahedral arrangement,  $\times 666$ . Fig. 3, Uninucleate pollen grain,  $\times 666$ . Fig. 4, Two-celled pollen grain,  $\times 666$ . Fig. 5, L.S. of ovule showing megaspore mother cell,  $\times 666$ . Fig. 6, Linear tetrad of megaspores,  $\times 666$ . Fig. 7, Linear tetrad of megaspores showing functional megaspore and degenerating megaspores,  $\times 666$ . Figs. 8-9, Two and four nucleate embryosacs,  $\times 666$ . Fig. 10, Organised embryosacs,  $\times 666$ .

The ovular primordium is an erect papilla which arises from the base of the loculus. Antichinal and perichinal divisions of the cells on the adaxial side of the ovule lead to unilateral growth as a result of which the apex of the ovule lies parallel to the funiculus in the anatropous condition. The ovules are unitegmic and tenuinucellate, the integument being nucavate. When the ovular primordium is still erect a hypodermal archesporial cell becomes

differentiated which directly functions as the megaspore mother cell (Fig. 5). The megaspore mother cell undergoes the usual meiotic divisions and forms a linear tetrad of megaspores (Fig. 6) of which the chalazal one is functional (Fig. 7). Due to the pressure exerted by the growing chalazal megaspore and the unyielding nucellar epidermis, the three upper megaspores get crushed and eventually degenerate. The nucleus of the functional megaspore undergoes three successive mitotic divisions to give rise to an eight-nucleate embryo-sac of polygonum type (Figs. 8-10). When the embryo-sac is four-nucleate, the nucellus becomes disorganised so that the embryo-sac comes in direct contact with the integument. Integumentary tapetum is differentiated as in other investigated compositae (Figs. 9, 10). The integumentary tapetum does not surround the embryo-sac completely. The cells of the integumentary tapetum are uninucleate. The egg apparatus consists of two spindle-shaped synergids with the egg suspended in between

them. The synergids show neither hooks nor beaks. The antipodals are cellular, uninucleate and three in number. The two upper antipodal cells however are normal but the lower one is rather elongated and top-shaped. The secondary nucleus is placed near the egg cell. Fertilisation is porogamous.

My thanks are due to Professor S. Shamanua for guidance and to Rev. Fr. Saldanha, S.J., for determining the species. My thanks are also due to Rev. Fr. A. P. Menezes, S.J., Principal, St. Joseph's College, Bangalore, for his encouragement.

Dept. of Botany, S. SUNDARA RAJAN.  
St. Joseph's College,  
Bangalore-1, December 6, 1967.

1. Davis, G. L., *Australian J. Bot.*, 1962, **10**, pl. 12.
  2. —, *Ibid.*, 1964, **12**, 142.
  3. Schnarf, K., *Vergleichende Embryologie der Angiospermen*, 1931.
  - \*4. Soueges, R., *C. R. ac.*, Paris, 1920, **171**, 254, 356.
  5. Venkateswarulu, J. and Maheswari Devi, H., *Proc. Ind. Acad. Sci.*, 1955, **41 B**, 38.
- \* Original not seen.

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## REVIEWS AND NOTICES OF BOOKS

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**The Vitamins** (Vol. 1). Second Edition.  
Edited by Sebrell and Harris. (Academic Press, Inc., New York and London), 1967. Pp. xiii + 570. Price \$25.00.

This series presents an invaluable and complete compilation of the latest information on all the vitamins. Among the areas treated in detail are the chemistry, preparation, biogenesis, biochemistry, pharmacology, toxicology, deficiency effects in man and animals, and methods of determination and requirements of all the vitamins. These volumes will be of interest to research workers, specialists, and graduate students.

Volume 1 contains the following articles: VITAMIN A AND CAROTENE—Nomenclature and Formulas; Chemistry; Industrial Preparation and Production; Occurrence in Foods; Standardization of Vitamin A Activity; Biogenesis of Vitamin A and Carotene; Active Compounds and Vitamin A Antagonists; Biochemical Systems; Effects of Vitamin A Deficiency in Animals; Effects of Vitamin A Deficiency in Man; Pharmacology and Toxicology of Vitamin A; Requirements of Vitamin A in Animals; and

Requirements of Vitamin A in Man; Ascorbic Acid—Nomenclature and Formulas; Chemistry; Industrial Preparation; Estimation; Occurrence in Foods; Standardization of Activity; Biogenesis of L-Ascorbic Acid in Plants and Animals; Active Compounds and Ascorbic Acid Antagonists; Biochemical Systems; Biochemical Detection of Deficiency; Effects of Ascorbic Acid Deficiency in Animals; Effects of Ascorbic Acid Deficiency in Man; Pharmacology; Ascorbic Acid Requirements of Micro-organisms; Ascorbic Acid Requirements of Animals; and Ascorbic Acid Requirements of Man. C. V. R.

**Solid State Electronics—International Series in Pure and Applied Physics.** By Wang. (McGraw-Hill Book Company, International Division, 330, West 42nd Street, New York 10036), 1966. Pp. xxi + 777. Price not given.

Based on the lecture notes of courses taught by the author at the University of California, Berkeley, this deals with solid-state electronic devices that utilize the conductive, dielectric, magnetic, and optical properties of materials.

The main objective is to introduce the student to the modern theory of solid-state devices, starting with a discussion of material properties. In a rapidly expanding field such as solid-state electronics, it is important that the student obtains an over-all view of the whole field. Therefore, this book, which attempts to bridge the gap between physics and electrical engineering, is written as an introductory text at the advanced senior and graduate level.

The contents of this book are: 1. Atomic Structure and Quantum Theory; 2. Interatomic Forces and Crystal Structures; 3. Conduction Mechanisms in Semiconductors; 4. Transport Phenomena in Semiconductors and Metals; 5. Transport and Recombination of Excess Carriers; 6. Semiconductor Junction Devices; 7. Dielectric and Ferroelectric Materials; 8. Theory of Magnetism; 9. Paramagnetic Resonance Phenomena and Masers; 10. Ferromagnetism and Ferromagnetic Devices; 11. Optical Absorption and Emission Processes; and 12. Lasers and Related Optical Effects.

C. V. R.

**Annual Review of Astronomy and Astrophysics** (Vol. 5). Edited by Leo Goldberg. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1967. Pp. vii + 694. Price: U.S.A. \$ 8.50; Elsewhere \$ 9.00.

Volume 5 of *Annual Review of Astronomy and Astrophysics* was organized by the Editorial Committee in Pasadena, California, on May 8, 1965, with the valuable assistance of Professor Jesse L. Greenstein, Dr. Beverly Oke, and Professor Harold Zirin. The larger than average size of the volume is a measure both of the growth of astronomy and of the unusually high proportion of authors who succeeded in meeting the prescribed deadline for the submission of manuscripts.

The titles of the articles contained in this volume are: Magnetic Field of the Sun; On the Interpretation of Statistics of Double Stars; Astronomical Optics; Waves in the Solar Atmosphere; Determination of Masses of Eclipsing Binary Stars; Masses of Visual Binary Stars; Astronomical Fabry-Perot Interference Spectroscopy; Observing the Galactic Magnetic Field; OH Molecules in the Interstellar Medium; Structure of the Solar Corona; On the Origin of the Solar System; Ultraviolet and X-rays from the Sun; Extrasolar X-Ray Sources; Energetic Particles from the Sun; Quasi-Stellar Objects; The Dynamics of Disk-Shaped Galaxies;

Rotating Fluid Masses; Gamma Radiation from Celestial Objects; Thermonuclear Reaction Rates; Stellar Evolution Within and Off the Main Sequence; Cosmology; and Related Articles Appearing in Other *Annual Reviews*.

C. V. R.

**Annual Review of Physical Chemistry** (Vol. 18) - Edited by Henry Eyring. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1967. Pp. vii + 486. Price: U.S.A. \$ 8.50; Elsewhere \$ 9.00.

This volume contains the following articles: 1. The Svedberg and Fifty Years of Physical Chemistry in Sweden; Electron Spin Resonance; Field Emission; Molecular Structure; Gas Chromatography; Nuclear Magnetic Resonance; Transport Phenomena in Gases; Thermodynamics and Thermodynamics; Theory of Macroscopic Kinetics of Heterogeneous and Homogeneous-Heterogeneous Processes; Radiation Chemistry; High Pressure; Multiphoton Spectroscopy; Mechanisms and Kinetics of Hydrocarbon Combustion; Physical Organic Chemistry; Free Radicals; Microwave Spectroscopy and Molecular Structure; Quantum Theory of Atoms and Molecules; Sensitized Photochemical Processes in Biological Systems.

C. V. R.

**Recent Progress in Hormone Research** (Vol. 23). Edited by Gregory Pincus. (Academic Press Inc., New York and London), 1967. Pp. ix + 691. Price \$ 28.00.

The papers in this volume are those delivered at the 1966 Laurentian Hormone Conference which was held at Mont Tremblant, Quebec, during the period August 28 to September 2. Four major areas of research were explored during this meeting. They were concerned with thyroid physiology, a number of studies with thyroid hormones, contemporary developments in peptide hormone chemistry and biochemistry, and special studies of insulin physiology, particularly in man. The titles of the papers are: I. THYROID PHYSIOLOGY—1. The Long-Acting Thyroid Stimulator: Its Role in Graves' Disease; 2. Studies of Thyrotropin Physiology by Means of Radioimmunoassay; 3. Extrathyroid Effects of Some Antithyroid Drugs and Their Metabolic Consequences; 4. Thyroid Hormones and the Biochemistry of Amphibian Metamorphosis. II. STEROID HORMONES—1. Studies of the Mode of Action of Adrenal Steroids on Lymphocytes; 2. Biochemical and Morphological



Responses of Normal and Neoplastic Mammary Tissue to Hormonal Treatment; 3. Formation and Metabolism of Steroids in the Fetus and Placenta; 4. Studies with the 3 $\alpha$ -Hydroxysteroid Dehydrogenase from *Pseudomonas testosteroni*—Enzyme-Substrate Complementarity as the basis of Selectivity and Steric Specificity; 5. Disorders of Adrenal Steroid Biogenesis. III. Peptide Hormones: 1. New Approaches to the Chemical Synthesis of Peptides; 2. Contemporary Developments in the Biochemistry of the Gastro-intestinal Hormones. IV. INSULIN AND THE PANCREAS: 1. Synthetic Insulins; 2. Non-suppressible Insulin-like Activity of Human Serum: Purification, Physicochemical and Biological Properties and its Relation to Total Serum ILA; 3. Effect of Amino-Acids and Proteins on Insulin Secretion in Man.

C. V. R.

#### Secretory Mechanisms of Salivary Glands.

Edited by L. H. Schneyer and C. A. Schneyer.  
(Academic Press, Inc., New York and London),  
1967. Pp. xvii + 389. Price \$ 13.50.

This represents the Proceedings of an International Conference on Mechanisms of Salivary Secretion and Their Regulation, held at the University of Alabama Medical Centre, Birmingham, August 9-11, 1966.

The editors of this volume present papers by recognized authorities on the anatomy, physiology, and biochemistry of salivary and pancreatic secretions. The volume covers transport of electrolytes, glandular growth and development, and physiological and biochemical regulations of glandular activity. The level of treatment is advanced; the subjects discussed are of interest to teachers and clinicians as well as to students and research workers in gastroenterology, dentistry, surgery, and the basic medical sciences.

C. V. R.

**Crop Responses to Water at Different Stages of Growth.** By P. J. Salter and J. E. Goode.  
(Published by Commonwealth Agricultural Bureaux, Central Sales, Farnham House, Farnham Royal, Bucks., England), 1967.  
Pp. 246. Price 45 sh. or \$ 6.80.

The provision of irrigation water and the ways of using it for maximum efficiency in crop productivity have become world-wide problems. Scientific studies relating irrigation at specific

growth stages of the crop and the resulting yield have been going on in recent years not only in countries with vast irrigational facilities but also, of what is of greater importance, in the arid, semi-arid and subhumid regions of the world. Despite the large number of experiments carried out on this subject the results do not appear to be generally known. It is the object of the Commonwealth Agricultural Bureaux to present in the publication under review the main results of such work and to discuss critically the possible explanations of the differential response to soil moisture conditions found at different stages of growth of certain crops.

After a brief introductory first part, the review deals in Part II with crops grown as Annuals or Biennials which include wheat, maize, barley, oats and other cereals, and leguminous and vegetable crops. Part III deals with Perennial crops, Fruit and other tree and bush crops under separate heads of vegetative growth, root growth, flower-bud formation and development, fruit set and development, fruit yield, disorders and diseases.

The final discussion emphasises the principles that are fundamental to preparing any investigation programme designed to provide water at times when crops will benefit most, and to withhold water at times when the response will be negligible or even adverse.

The book brings together research findings on the subject from widely scattered literature. The bibliography alone covers 40 pages of nearly 1200 references.

A. S. G.

#### Books Received

*Hand-Book of Chemistry* (Revised 10th Edn.).

Edited by N. A. Lange, G. M. Forker.  
(McGraw-Hill Book Co., New York), 1967.  
Pp. xiv + 2001. Price \$ 12.00.

*Infra-red Spectroscopy in surface Chemistry.*

By M. L. Hair. (Marcell Dekker, Inc., New York), 1967. Pp. xiii + 315. Price \$ 15.75.

*Theory of Linear Active Networks.* By E. S. Kuh, R. A. Rohrer. (Holden-Day, Inc., 500, Sansome Street, Sanfrancisco), 1967. Pp. xii + 650. Price \$ 19.25.

*Essays in the History of Embryology and Biology.*

By J. M. Oppenheimer. (The M. I. T. Press, Book Centre Ltd., London N.W. 10, England), 1967. Pp. vi + 373. Price \$ 12.50.



## THE INDIAN ACADEMY OF SCIENCES : XXXIII ANNUAL MEETING

**T**HE Thirty-third Annual Meeting of the Indian Academy of Sciences was held on the 19th, 20th and 21st December 1967 in Madras at the invitation of the Madras University. The highlights of the session were the two full-day symposia organized by the two Centres of Advanced Studies, namely, those in Physics and in Botany, of the Madras University.

The session was inaugurated on the 19th evening by Dr. A. Lakshmanaswami Mudaliar, Vice-Chancellor of the Madras University, in the University's new and capacious Centenary Auditorium before a very large audience. Sir C. V. Raman, Nobel-Laureate and President of the Academy, delivered the Presidential Address on "The Atmosphere of the Earth".

The full-day symposium on the 20th was on "Crystallography and Molecular Structure" under the Chairmanship of Prof. G. N. Ramachandran, Director of the Centre of Advanced Studies in Physics. After an introductory talk by the Chairman on "Biomolecular Structure", the following papers were presented and discussed in the forenoon session: "Conformation of Biological Molecules" by V. Sasisekharan; "X-Ray Crystallographic Investigation of Peptide Crystals" by K. Venkatesan; "Some Recent Studies on Crystal Structures by X-ray and Neutron Diffraction" by V. M. Padmanabhan; "The Structure and Dynamics of the Water Molecule in Crystals" by S. K. Sikka, A. Sequeira and R. Chidambaram (presented by A. Sequeira).

In the afternoon session the following two papers were presented and discussed: "On the Periodic Occurrence of Stacking Faults in Certain Close-packed Crystal Structures" by K. N. Rai and P. Krishna (presented by P. Krishna); "Fourier Methods of Treating Anomalous Dispersion Data" by R. Srinivasan.

The symposium was followed by an interesting talk by Sir C. V. Raman on "The Origin of Floral Colours".

The full-day symposium on the 21st was on "The Impact of Physiology on Plant Pathology" under the Chairmanship of Prof. T. S. Sadasivan, Director of the Centre of Advanced Studies in Botany. The Chairman's introductory address was on "Physiology and Phytopathology".

In the forenoon session the following papers were presented and discussed: "Physiology of Virus-Infected Plants" by K. Ramakrishnan and K. K. N. Nambiar (presented by Ramakrishnan); "Trace Metals in Plant Diseases" by A. Appa Rao; "Physiology of Disease-Resistance in Sugarcane with Particular Reference to Red Rot" by K. V. Srinivasan; "Enzymes in Pathogenesis" by D. Subramanian; "Respiration in Pathogenesis" by R. Narayana Swamy; "Stress Physiology in Plant Bacterial Diseases" by M. V. Nayudu.

In the afternoon session the following papers were discussed: "Applications of Plant Tissue and Cell Culture in the Study of Physiology of Parasitism" by R. Maheshwari; "Tracer Techniques in Plant Pathology" by S. Suryanarayanan; "Immunoserology in the Study of Plant Pathogens" by R. Kalyanasundaram.

There were afternoon visits to laboratories and experimental farms.

There were two evening popular science lectures on the 20th and the 21st. The first lecture was by Dr. S. Ramaseshan of the National Aeronautical Laboratory, Bangalore, on "The Quest for New Materials". The second was by Dr. A. R. Gopal-Ayengar of the Bhabha Atomic Research Centre, Modular Laboratory, Bombay, on "The Genetic Language".

# ABSTRACTS OF PAPERS PRESENTED AT THE THIRTY-THIRD ANNUAL MEETING OF THE INDIAN ACADEMY OF SCIENCES

## A. SYMPOSIUM ON CRYSTALLOGRAPHY AND MOLECULAR STRUCTURE

(20-12-1967)

Chairman: PROF. G. N. RAMACHANDRAN

### Some Recent Studies on Crystal Structures by X-Ray and Neutron Methods

V. M. PADMANABHAN

Nuclear Physics Division, Apsara Reactor  
Bhabha Atomic Research Centre, Bombay

#### Potassium Mercuric Tribromide Monohydrate

The crystal structure of potassium mercuric tribromide monohydrate has been determined by X-ray 3D-data. The structure consists of four molecules linked by hydrogen bonds and van der Waals forces in a unit cell of dimensions  $a = 4.37$ ,  $b = 16.87$ ,  $c = 10.14$  Å and the space group  $Cmc2_1$ . The mercury atom is surrounded by four bromines in an irregular tetrahedron. One of the bromines is shared by two mercury atoms, resulting in a zig zag chain of Hg-Br-Hg along the  $a$ -axis. The other bromines are held by hydrogen bonds of the water molecule. Although positions of the hydrogen atoms have not been determined, it is believed that there exists a bifurcated hydrogen bond in the structure.

#### Cis Cobalt-diazido Bisethylene Diamine Nitrate

This cobalt complex is orthorhombic, space group  $Pnma$ , eight-formula units per cell. The structure has been determined from Patterson projections and refined by the least-squares method with two-dimensional intensity data.

The cobalt atom has the usual distorted octahedral co-ordination with four N atoms of the ethylene diamine group and two N atoms from each of the azido group. The bond distances in ethylenediamine molecule are normal and agree with the reported values. The azido group is linear and appears to be unsymmetric. The valence angle Co-N-N is about  $120^\circ$ . The two nitrate groups are stacked one above the other and form a close packing inside the complex ion. So far only one structure of a co-ordination compound bonding an azido group has been reported in the literature.

#### Potassium Sulphamate

A single crystal neutron diffraction investigation of potassium sulphamate has been made in which the intensities of 501 reflections were

measured. The structure was refined by least-squares technique with individual anisotropic temperature factors. The heavy atom positions obtained agree well with those of Jeffrey and Stadler. The hydrogen atom positions differ substantially from those postulated from the X-ray work. The sulphamate ions are packed one above the other with hydrogen bonds linking them in infinite chains parallel to the  $c$ -axis.

#### Triglycine Sulphate

All the hydrogen atom positions have been determined with the help of intensities of 410 reflections in the three prism zones collected by neutron diffraction methods. The positions of these atoms are discussed in relation to the structure of the compound.

### On the Periodic Occurrence of Stacking Faults in Certain Close-Packed Crystal Structures

K. N. RAI AND P. KRISHNA

Department of Metallurgy, Banaras Hindu  
University, Varanasi

A number of close-packed crystal structures like ZnS, SiC, CdI<sub>2</sub>, PbI<sub>2</sub>, etc., are known to display a high concentration of stacking faults in their basal planes. The insertion of stacking faults is to be expected since, thermodynamically, the different manners of close-packing atoms lead to structures with very nearly the same free energy. The stacking faults should, however, be distributed randomly giving rise to a one-dimensionally disordered structure. While this does occur, there is a marked tendency for the stacking faults to occur periodically, often with perfect crystalline regularity, over macroscopic distances, giving rise to a long-period lattice.

Till recently this was believed to be a growth feature associated with spiral growth around screw dislocations of large but non-integral Burgers vectors. This has, however, been disproved by recent experimental observations of various workers, and a fresh explanation is being sought.

It was suggested by Schneer in 1955 that different polytypes of a compound may be related by second or higher-order transformations since they differ little in their internal energies. He assumed that the phase-transformation from the cubic close-packed to the

hexagonal close-packed structure proceeds over a temperature range by infinitesimal steps, and the long-period polytypes represent intermediate states in the transition. At any intermediate temperature, assuming a Boltzman distribution of layers in the hexagonal (*h*) and cubic (*k*) states, it was shown that polytypic structures will correspond to potential minima if they are characterised by a maximum number of interaction contacts between layers in unlike states.

This paper presents experimental evidence in favour of Schneer's theory. It is shown that nearly all known polytypes of ZnS, SiC, CdI<sub>2</sub> and PbI<sub>2</sub> are characterised by a maximum number of unlike interaction contacts. In ZnS the phenomenon appears to be a sensitive function of the conditions of growth. It is possible that individual polytypes may be associated with specific temperatures within a short transition range.

#### The Structure and Dynamics of the Water Molecule in Crystals

S. K. SIKKA, A. SEQUEIRA AND R. CHIDAMBARAM  
*Bhabha Atomic Research Centre, Trombay  
Bombay*

The programme of the Trombay group on the investigations of hydrated crystals by neutron diffraction is reviewed. The structure of the latest member of the series, BeSO<sub>4</sub>·4H<sub>2</sub>O, has been solved by direct methods using symmetry minimum and minimum function techniques and without making use of the X-ray structure information. The available data on the structure and co-ordination of the water molecule are summarised and the stereochemistry of the O-H . . . O hydrogen bonds in the structure is discussed. An electrostatic model for calculating the potential functions for the librations of the water molecule in crystals is discussed. Some preliminary calculations for K<sub>2</sub>C<sub>2</sub>O<sub>4</sub>·H<sub>2</sub>O are also presented.

#### Fourier Method of Treating Anomalous Dispersion Data

R. SRINIVASAN  
*Centre of Advanced Study in Physics  
University of Madras, Madras*

A Fourier method of treating the anomalous dispersion effect in X-ray intensity data is suggested. It is shown that the 'anomalous dispersion corrections to the atomic scattering factor leads to a formal representation of 'real'

and 'imaginary' components in the electron density distributions in the direct space. The necessary formulas are derived and their possible application to the determination and refinement of the real ( $\Delta f'$ ) and imaginary ( $\Delta f''$ ) correction terms are discussed.

Some results of the recent studies on the theory of the beta synthesis with wrong atoms, are also presented.

#### X-Ray Crystallographic Investigation of Peptide Crystals

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X-ray crystallographic investigations on simple peptide crystals like l-threonyl-l-phenylalanine, p-nitrobenzyl ester hydrobromide, l-prolyl-l-phenylalanine-o-methoxy hydrobromide, l-glutamyl-l-methionine, glycyl-dl-phenylalanine, etc., are being carried out in this laboratory with the view to determine accurately the bond lengths and bond angles of the various components as well as to gain knowledge regarding the backbone and side group conformations. The stereochemical configurations as derived from least squares refinement using three-dimensional X-ray intensity data are presented. The role of hydrogen bonding in determining the spatial arrangement of the side chains in the crystals is discussed.

#### B. SYMPOSIUM ON IMPACT OF PHYSIOLOGY ON PLANT PATHOLOGY (21-12-1967)

Chairman: PROF. T. S. SADASIVAN

Physiology and Phytopathology  
T. S. SADASIVAN  
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From a descriptive science in the latter part of the last century and well into the early part of this century, plant pathology, in the last four decades has steadily replaced much of the worn-out classical ways of approaching disease etiology and syndrome to a modern streamlined discipline with integrated reasoning into the causes of infection. Indeed, the impact of the more precise physical sciences, particularly biochemistry, has played a significant role in this evolutionary process and with the aid of sophisticated techniques evolved by plant physiologists much is now known of the biochemistry of the infected plants. Pioneering

work in these areas were initiated by plant virologists and later by those working in the field of mycopathology. Critical tissue respiration measurements, derangement in carbohydrate and nitrogen metabolisms, transpiratory disturbances bringing in its wake ionic imbalance, exaggerated auxin relationships, isolation and characterization of fungal toxins and antibiotics in the rhizosphere and *in vivo* formation and accumulation of abnormal metabolite(s) (phytoalexins) consequent on pathogenesis, enzymological changes in tissues, availability of energy substances around root systems, cellular changes in RNA and nitrogen synthesis under viral infections are the more important achievements in studying the biochemistry of infected plants.

Quite recently, purification, isolation, characterization and study of the properties of the "satellite" virus and its dependence on tobacco necrosis virus for *in vivo* multiplication and the working out of the amino-acid sequence in virus nucleoproteins and the fascinating work on the complexity of the coding characteristics of this smallest known particulate plant virus are achievements. Of equal significance is the discovery that the derobed tobacco mosaic virus nucleic acid (without its protein shell) is itself infective. The ridding of potato from viruses by tissue culture of the meristematic virus-free zone and heat therapy are exciting fields of control based on sound scientific reasoning and practical achievement. The role of chemotherapy and the immense field of phytotoxicity and the use of nucleic acid analogues in restricting virus multiplication *in vivo* are fields where we could hopefully look for breakthrough in practical pathology.

The relationships of vectors (whether they be insects, nematodes or fungi) in virus multiplication and transmission and host physiology which they alter are significantly complex to warrant intensive studies.

#### Physiology of Virus-Infected Plants

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The physiology of virus-infected plants has been ably reviewed recently by Diener (1963). Much of the information has emanated from work on mosaic type diseases. Information available indicates derangements in all major

metabolic activities such as photosynthesis, respiration and carbohydrate metabolism, organic acid metabolism and nitrogen metabolism. By and large, however, it may be stated that information has been gathered from studies on fully virus diseased plants. Little information is available on the sequence of physiological changes from inoculation to full development of virus disease symptoms. In this paper, therefore, it is proposed to discuss such changes in pigeon-pea plants affected by the sterility mosaic disease and cassava plants affected by the cassava mosaic disease.

Though the major facets of metabolic activities have been studied we would like to present here only a few of the most interesting results obtained. These concern: (1) activity of chlorophyllase, (2) ferrous and ferric iron changes, (3) inorganic and organic phosphorus and (4) respiration.

In both healthy and diseased plants chlorophyll A and B increased with age. However, there were significantly lower amounts of these pigments in diseased plants from onset of the disease. Chlorophyllase activity increased with age in healthy and diseased plants, the increase in diseased plants being very much steeper. Disease did not result in a significant reduction in total iron. However, there appeared to be a progressive significant conversion of ferrous iron to ferric iron in diseased leaves. Diseased leaves at all ages contained higher quantities of total phosphorus. Much of this phosphorus was in the organic form in diseased leaves suggesting a greater conversion of inorganic phosphorus to the organic form as the disease progressed. Respiratory rates increased with progress of disease up to the production of obvious symptoms. Thereafter respiratory rates dropped and even reached levels lower than in healthy leaves. In pigeon-pea leaves cytochrome oxidase activity increased with progress of disease and age and was much higher in diseased leaves than in healthy leaves. Mitochondrial nitrogen was much higher in the diseased than in healthy leaves. There was also an increase in activity of succinic oxidase in diseased leaves.

#### Trace Metals in Plant Diseases

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Trace metals—iron, manganese, boron, copper, zinc and molybdenum—although

required in small quantities by plants play a very important role in health and disease of plants. They function, mainly, as constituents of enzymes of the plants as well as the pathogenic micro-organisms. The essentiality of all trace elements required by plants, with the exception of boron, has been demonstrated for plant pathogens. Growth, sporulation and physiological functions like toxin production in fungi are profoundly influenced by the availability of these elements. Among the various elements there is considerable interaction leading to synergistic and antagonistic effects on the hosts and the pathogens.

Apart from their direct effect on plants and pathogens, trace metals are involved in host-pathogen interactions leading to pathogenesis. The influence of certain elements notably zinc and manganese, through their effects on sporulation and survival of the pathogens and rhizosphere microflora, on the development of soil-borne fusarial wilts is now well known. The wilt toxins produced by these fungi are potentiated by iron by forming toxin-metal chelates causing local deficiencies and excesses within the plant.

The effects of trace metals on plants when they are in excess and deficiency are relatively better known than those involving host pathogen interactions. The limited experimental evidence reveals that trace metals are closely concerned with pathogenesis and there is scope and need for further work with the ultimate aim of controlling plant diseases by manipulation of metal availability through soil amendments.

#### Physiology of Disease Resistance in Sugarcane with Particular Reference to Red Rot

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Resistance to red rot, wilt and bacterial red stripe is a hypersensitive reaction (HR). A detoxification mechanism possibly functions against eye spot and leaf scald. Against smut a hypersensitive anti-infectious defence operates in highly resistant varieties but in varieties with moderate resistance there is suppression of tillering and a linear elongation of the stem. Resistance to *Pythium* root rot is an exclusion phenomenon depending on the antagonistic character of the rhizosphere microflora.

HR in red rot operates against infection and against enlargement of the disease lesion. It is related to the speed of activation of polyphenol oxidase (PPO). In an incompatible

host-parasite (H/P) combination at 30° C, PPO activity reaches a peak between 6 and 10 days after infection and falls off steeply thereafter and is strictly localised. In a compatible H/P combination it is relatively weak to begin with, reaches a peak 3 weeks after infection considerably behind the advancing margin of the lesion and falls gradually. At 35° C all H/P combinations are incompatible though the temperature itself is not lethal either to the fungus or to the host tissue. Between 25 and 32° C differences between resistant and susceptible varieties are clearly and rapidly brought out and at 16° C the reaction is slow to develop.

On juvenile leaves following germination of spores of an avirulent race, leachates contain a factor inhibiting germination of spores including those of the more virulent races. This would indicate the presence of a phytoalexin.

A second aspect of resistance, important in the epidemiology of red rot, is the development of dormant infections in bud scales and leaf scar tissue. Penetration of host cells is followed by the formation of thick-walled chlamydospores. This happens when resistance is partial. In active lesions in the stem, chlamydospores are formed in the periphery of the lesion in a partially incompatible H/P reaction. Aqueous extracts of tissues adjacent to a resistant type of lesion induce formation of abundant chlamydospores in culture. It appears possible that increase of phenols to sublethal concentrations in host cells as a response to infection triggers the development of dormant bodies of the parasite in intermediate H/P combinations.

A third feature of H/P interactions in red rot is the rate of development of degenerate adaptations in the pathogen in host tissues. This is characteristic of several host varieties. At > 32° C the majority of reisolates from infected tissues are of the avirulent type while reisolations made from infected host tissues maintained at 20° C and less yield mostly the parental virulent type. This possibly has a bearing on the prevalence of degenerate types of the pathogen in tropical areas where red rot is no problem and the persistence of virulent types in sub-tropical and temperate areas where red rot is a major hazard to sugarcane.

#### Enzymes in Pathogenesis

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The events leading to the development of the functional condition which we call as "Disease"

are included in the term Pathogenesis and this represents the dynamic aspect of Plant pathology. Disease is caused not merely by the association of a parasite and a host but by their interaction. The early steps in this process start when the pathogen breaks its way through the host tissues and cells. At this stage, the ability of the pathogen to degrade the constituents of cell walls such as pectin, cellulose, hemicelluloses and possibly proteins by secreting the appropriate hydrolytic enzymes would seem important. Although evidence for such enzymatic breakdown of cell wall material has been obtained in a large number of diseases such as soft-rots, damping-off of seedlings, foot-rot of cereals and root rots and possibly in vascular wilts, it still remains equivocal. This, however, is only due to the absence of the technique for purifying and identifying the different enzymes from sources *in vivo*, namely the enzymes secreted by the pathogen and those produced by the host itself. This is important because, many of these enzymes are of common occurrence in both the host plants and the pathogens. A large body of evidence that has been presented so far makes it clear that these extra-cellular, hydrolytic enzymes are important biochemical weapons the pathogens employ in mounting the attack on their hosts.

Another facet of this problem concerns the reaction of the host tissues to this attack. Enzymes such as Polyphenol oxidase, Peroxidase are stimulated in the affected tissues. Their increased activity could initiate a chain of events at the cellular and tissue levels. The actual mode by which this observed increase of oxidases is brought about is not clear. Their increased activity could reflect their increased synthesis by the host *de novo* in response to the attack by the pathogen. The possibility of their release from the sub-cellular particles and consequent activation cannot also be ruled out.

Be that as it may, the stimulated activity of these oxidases appears as the most important change in the course of host-parasite interaction. Activity of polyphenol oxidases lead to the formation of quinones which on polymerisation give rise to melanin-like pigments imparting a brown colouration to the diseased tissues. The intermediary production of quinones itself can affect the activity of various enzymes as they will act as non-specific protein precipitants. Peroxidase, likewise, can bring about the oxidation of a number of substances such as phenols, auxin, etc., in addition to its role

in detoxication of  $H_2O_2$  arising during altered metabolism. The need for an increased peroxidase action implying an increased production of  $H_2O_2$  is significant. In cotton plants infected by *Fusarium vasinfectum* a powerful oxidative deaminase activity has been recorded which would in turn lead to the formation of increased levels of  $H_2O_2$ .

### Respiration Under Pathogenesis

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An augmentation of respiration almost invariably follows pathogenic attack of plant tissues and is one of the physiological manifestations of disease. Aided by a knowledge of the physiology of respiration, plant pathologists have been investigating this alteration in the respiratory pattern following infection. Quantitative and qualitative changes have been recorded. The quantitative changes could be due to an increased availability of substrates for respiration or of phosphate acceptor adenosine diphosphate (ADP). Increased availability of ADP can be the result of an uncoupling of electron transport from phosphorylation of ADP or of an increased utilization of adenosine triphosphate (ATP) in synthetic processes. The possibility of production by the pathogen of an uncoupling toxin has been examined. Acceleration of synthetic processes has been recorded particularly in infection by obligate parasites. Increased oxygen uptake could also be due to increase in activity of terminal oxidases like polyphenol oxidase and ascorbic acid oxidase.

The causes of qualitative changes (alteration in respiratory pathways) are not easily explained. The possibility that such changes are actually due to the contribution by the pathogen cannot be ignored.

All these phenomena associated with respiration under pathogenesis are discussed with reference to the *Cercospora*-disease of groundnut and other host-parasite combinations.

### Stress Physiology in Plant Bacterial Diseases

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It is when a bacterial lesion is first visible that the bacterium would be multiplying most rapidly. Further expansion of lesion size suggests continuing interaction between the patho-

gen and host. Study of the infected host tissue prior to the lesion formation and during its expansion indicates changes in respiratory rate, growth-regulating substances, soluble organic compounds, phenols, proteins and enzymes. Toxins may be produced as in the case of wild fire of tobacco.

Interaction between host and pathogen involves production of some compounds and/or utilization of soluble organic compounds of the host cells by the pathogen, and a host reaction by producing compounds antagonistic to bacterial compounds and/or increased metabolic activity. Pathogen's multiplication necessarily involves increased synthesis of some compounds in the host cells, and less of others.

The visible after-effects of this interaction are retardation of growth rate of the host, premature senescence and death of the infected plant. Decreased photosynthesis, increased host catabolic activity, proteolysis, decreased carbohydrate content, and imbalanced enzymic activity contribute to these effects. Specific identification of the crucial changes in the affected host cell, like activity of some lipases, transamination and polymerisation of amino-acids or inhibition of some oxidases, would point to possibilities of controlling these abnormal physiological events and so control the disease.

#### Applications of Plant Tissue and Cell Culture in the Study of Physiology of Parasitism

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The technique of growing tissues and cells isolated from plants on nutrient media offers several advantages over intact plants for experimental studies. Precise control of chemical and physical regimen enable the study of the effects of a number of interacting factors on growth of cells; the latter conveniently measured in terms of increase in weight. Suspension cultures of cells make possible their use in certain studies hitherto possible only with micro-organisms. Clones and plantlets may be produced by the growth and differentiation of single cells *in vitro*. Micro-chambers permit continuous microscopic observations of various cellular features in single isolated living cells.

Comparative studies on tissue cultures derived from healthy and diseased tissue are useful in the study of the nature of self-limiting

and non-self-limiting overgrowths. One classic example showing the utility of the *in vitro* study in the physiology of diseased tissue is crown-gall. Tissue culture methods unequivocally established the autonomous nature of tumor cells. They also revealed differences in the biosynthetic pathways and membrane properties between normal and malignant cells. By isolation of single cell clones it was proved that teratoma tissue is composed entirely of tumor cells. It was also possible to reverse the teratoma state to a normal condition. The latter suggested that abnormal growth is possibly due to a change in the expression of genes rather than gene mutation.

The growth of obligate parasites on host tissue cultures has been attempted, aimed at their eventual axenic culture. Although their routine cultivation on tissue cultures has not yet been possible, nevertheless this approach has provided insights into certain factors determining penetration, infection, and multiplication of pathogen. The properties of host surface and the presence of vascular tissue appear to be important in certain host-parasite relationships. The effect of metabolites and analogs on viruses in tissue cultures should prove useful in studies of synthesis and inhibition of infectious nucleic acid.

The study of the interaction of the host and the parasite at cellular level is possible by growing both in microchamber. Details of infection process can be watched. The dynamic effects of toxin on plant cells can also be evaluated. Calluses derived from single cell bearing inclusion bodies in microchambers have been induced to differentiate *in vitro* demonstrating the totipotency of virus-infected cell.

Callus tissue is a favourable substrate for the aseptic cultivation of many plant-parasitic nematodes. Nematodes thus reared are useful in fulfilment of Koch's postulates. Tissue cultures are also useful in defining factors influencing nematode multiplication.

Tissue culture systems have been used as bioassays for growth regulators. Cytokinins produced by a plant-pathogenic bacterium and a *mycorrhizal* fungus have been recently identified. The role of cytokinins in other diseases is being investigated by using such bioassays.

Plant tissue and cell culture if used in conjunction with histo-chemical and biochemical techniques should greatly aid in our understanding of the physiology of parasitism.

## Tracer Techniques in Plant Pathology

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As in other fields of biology, application of tracer techniques to problems of plant infection has led to many significant contributions of fundamental importance. Particularly, the study of metabolic pathways in obligate parasites like rust has been considerably facilitated by the use of stable and radioactive isotopes. The ability of wheat stem rust uredospores to utilize simple inorganic compounds like  $\text{NH}_4\text{Cl}$  has been demonstrated by feeding the spores with the  $\text{N}^{15}$  enriched compound and subsequent analysis of the products by mass spectrometry. The radioactive Carbon-14 has been widely used in many studies connected with uredospore metabolism. For instance, the relative contribution of the EMP and Pentose phosphate pathway (PP) in the production of respiratory  $\text{CO}_2$  could be assessed, though not unequivocally, by studying the relative rates of release of  $\text{C}^{14}\text{O}_2$  from glucose specifically labelled in position 1 and 6. Such studies indicate a low value of the  $\text{C}_6/\text{C}_1$  ratio for uredospores suggesting that a high proportion of the respiratory  $\text{CO}_2$  is released through the PP pathway. Low  $\text{C}_6/\text{C}_1$  ratio is also characteristic of rust-infected tissue. Again, specifically labelled fatty acids ( $\text{C}_2$ - $\text{C}_9$ ) have been useful in studying the functional role of the TCA and glyoxylate cycles in uredospores. Evaluation of the distribution of radioactivity between the various carbons of the glutamic acid skeleton has been a useful index in the assessment of the TCA and glyoxylate cycles.

Autoradiography is another technique which has been successfully employed in the elucidation of certain metabolic changes in the infected plant. Using  $\text{P}^{32}$  and  $\text{C}^{14}$  the mobilization of materials to the infection court has been demonstrated in the case of diseases caused by obligate parasites. Microautoradiography with tritium labelled compounds has thrown considerable light on the host-parasite relationships in rust diseases. Qualitative and

quantitative changes in RNA and protein are characteristic of parasitised plant tissues. *De novo* synthesis of proteins, especially isoenzymes, occurs as a consequence of infection. However, information is lacking on the changes in messenger, transfer or ribosomal RNA in host-parasite associations. Hopefully these cell-biological aspects of host-parasite relations could be solved by diligent use of tracer techniques and cell-free systems.

## Immunoserology in the Study of Plant Pathogens

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The parasitic attributes of the pathogen correspond—like lock and key—to similar or opposite qualities of the host. They are usually complementary pairs. Under pathogenesis the host is diseased, but from the standpoint of the pathogen the host provides the congenial environment. In evolving itself to a parasitic mode of life the pathogen must have adjusted its synthetic mechanism to be in tune with that of the host. The above hypothesis could be verified if one analyses the nucleoprotein of the host and parasite.

Plants unlike animals do not completely recover from infection and display the typical immunity. However, the plant pathogens, fungi or bacteria, do possess antigenic constituents. It has been possible to produce antibodies against plant pathogenic bacteria and fungi in experimental animals like rabbits and guinea-pigs, and demonstrate them using the common antigen-antibody reaction. In fact using immunoserology it is possible to compare and differentiate strains and species of pathogenic fungi and bacteria. Data to substantiate this are presented.

Furthermore, it is now believed that a strong common antigen relationship between a host and parasite might account for the host specificity exhibited by many plant pathogenic fungi and bacteria. Data in support of this view are also presented.



# SOME METAL CHELATES OF o-MERCAPTOBENZOIC ACID

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THE stepwise stability constants of the chelates of o-mercaptobenzoic acid with zinc (II), nickel (II), cobalt (II), iron (II), and manganese (II) have been determined in 45% (v/v) aqueous alcohol at 30°, 40° and 50° C. at an ionic strength of 0.15. The thermodynamic functions  $\Delta F^\circ$ ,  $\Delta H^\circ$  and  $\Delta S^\circ$  have also been evaluated at these temperatures. The behaviour of iron (III) and copper (II) towards o-mercaptobenzoic acid has also been studied. This investigation was undertaken in order to obtain more information on the manner in which the mercaptide sulphur complexes with divalent metal ions and to make comparisons with the corresponding oxygen compounds. The Calvin<sup>1</sup>-Bjerrum<sup>2</sup> potentiometric titration technique has been used to study the behaviour of Zn(II), Ni(II), Co(II), Fe(II) and Mn(II) with o-mercaptobenzoic acid. Previous work on the chelate stabilities of mercaptoacetic acid,<sup>3</sup>  $\beta$ -mercaptopropionic acid,<sup>4</sup> mercaptosuccinic acid,<sup>5</sup> 6-mercaptapurine<sup>6</sup> and thioxine<sup>7</sup> have shown that the Zn(II) complex is more stable than the corresponding Ni(II) complex. In addition, these mercaptans tend to reduce Cu(II) to Cu(I). The present study reveals that o-mercaptobenzoic acid behaves in a similar manner towards these metal ions.

The general procedure employed for the determination of chelate formation constants was to titrate a mixture of the ligand and mineral acid to which sufficient sodium perchlorate had been added to maintain a constant ionic strength of 0.15 in the presence and absence of the metal, with standard sodium hydroxide solution and determine the pH of the solution after each addition. The ratio of the ligand to metal was varied from 1:1 to 1:6. All solutions were titrated in an atmosphere of nitrogen. All metals were added as perchlorates. o-Mercaptobenzoic acid (Evans Chemetics product) was purified as described by Allen and Mackay.<sup>8</sup> Aqueous alcohol (45% v/v) has been used for all titrations. The ionisation constant of the mercapto group of o-mercaptobenzoic acid was determined spectrophotometrically and that of the carboxyl group potentiometrically using the same ionic strength. Values of the formation function  $\bar{n}$  and the negative log of the free ligand concentration  $pL$  and  $\log K$  have been calculated

using the method of Bjerrum<sup>2</sup> as modified by Calvin and Wilson,<sup>1</sup> and the free energy of complex formation from  $\Delta F^\circ = -RT \ln K$ , the ligational enthalpy from

$$\Delta H^\circ = 2.303 RT_1 T_2 (\log K_2 - \log K_1) / (T_2 - T_1)$$

and entropy from

$$\Delta S^\circ = \frac{\Delta H^\circ - \Delta F^\circ}{T}$$

The titration curves in the presence of metal ions reveal the overall stoichiometry of the reactions between these ions and o-mercaptobenzoic acid. The titration curves of o-mercaptobenzoic acid in the presence of metal ions correspond to a stoichiometry of 1:1 and 2:1 o-mercaptobenzoic acid to metal. Conductometric studies also indicate the presence of these two chelates. Ni(II) forms dark violet, Zn(II) colourless, Mn(II) yellowish-brown, Co(II) dark-brown, Fe(II) green, and Fe(II) blue chelates. Table I gives the stepwise formation constants  $\log K_1$  and  $\log K_2$  for these five metals at 30°, 40° and 50° C. together with  $\Delta F^\circ$ ,  $\Delta H^\circ$  and  $\Delta S^\circ$  values at these three temperatures. From the values given in Table I it is seen that the stabilities of the complexes conform to the Irving-Williams Series<sup>9</sup>  $Mn < Fe < Co < Ni < Zn$ .  $\log K_1$  for o-mercaptobenzoic acid chelates is greater than the corresponding values for salicylic<sup>10</sup> and anthranilic<sup>11</sup> acids. In this connection it is noteworthy that Sidgwick<sup>12</sup> has compared the relative donor properties of oxygen and sulphur and showed that, in general, the donor properties of sulphur are dependent, to a larger extent, on the acceptor properties of the metal. On the other hand, according to Sidgwick, oxygen and nitrogen may be considered quite similar with respect to their tendency to complex with metal ions. Therefore, it is not surprising that the o-mercaptobenzoic acid Zn(II)-chelate is more stable than the salicylic acid and anthranilic acid Zn(II)-chelates, nor is the fact that there is a reversal in the order of stabilities between the corresponding Ni(II) and Zn(II)-chelates of mercapto and aminobenzoic acids, since Zn(II) would appear to accept sulphur as the donor atom more readily than would nitrogen. It is suggested that this may be attributed to a steric effect, since the sulphur atom is bigger than the nitrogen atom.

TABLE I

Temperature ° C.	Zn (II)	Ni (II)	Co (II)	Fe (II)	Mn (II)
			$\log K_1^\circ$		
30	8.4483	7.0792	6.0264	5.4533	5.0438
40	8.5990	7.3435	6.1951	5.5697	5.1458
50	8.8389	7.6439	6.3475	5.7158	5.2774
			$\Delta F_1^\circ$ (Kcal./mole)		
30	-11.71	-9.817	-8.356	-7.561	-6.993
40	-12.32	-10.52	-8.876	-7.980	-7.372
50	-13.07	-11.30	-9.385	-8.450	-7.802
			$\Delta H_1^\circ$ (Kcal./mole)		
30-40	6.540	11.48	7.321	5.053	4.427
40-50	11.10	13.90	7.050	6.761	6.088
			$\Delta S_1^\circ$ (cal./mole-deg)		
30	60.24	70.31	51.75	41.62	37.70
40	67.55	75.61	51.33	44.39	40.35
50	74.82	78.02	50.90	47.09	42.99
			$\log K_2$		
30	5.9932	4.4559	4.4354	4.4092	4.0531
40	6.2035	4.6404	4.5509	4.4812	4.1845
50	6.3845	4.8032	4.6974	4.6218	4.2800
			$\Delta F_2^\circ$ (Kcal./mole)		
30	-8.310	-6.1800	-6.151	-6.115	-5.622
40	-8.888	-6.6460	-6.519	-6.419	-5.995
50	-9.439	-7.101	-6.945	-6.832	-6.327
			$\Delta H_2^\circ$ (Kcal./mole)		
30-40	9.126	8.007	4.969	3.125	5.675
40-50	8.389	7.532	6.779	6.504	4.419
			$\Delta S_2^\circ$ (cal./mole-deg.)		
30	57.55	46.82	36.70	30.50	37.30
40	56.37	46.05	39.60	35.89	35.27
50	55.20	45.30	42.47	41.30	33.29

The stability constants of the Ni(II)-chelates are consistent with the values reported<sup>13</sup> already in 50% aqueous dioxane. Nigam and co-workers<sup>14</sup> have reported  $\log K_1 = 9.1$  and  $\log K_2 = 11.2$  for the Zn(II)-chelate and  $\log K_3 = 11.76$  in the case of the Co(II)-chelate.<sup>15</sup> Conductometric and potentiometric titrations in the present work show evidence only for a 1:2 complex. The present values indicate that the order  $\log K_1 > \log K_2$  holds good. The  $\Delta F^\circ$  values are negative and the  $\Delta H^\circ$  and  $\Delta S^\circ$  values positive. Thus the heat and entropy changes favour complex formation. The high values of the thermodynamic functions may be attributed to the strength of the metal-sulphur bond.

When copper (II) salt was added to a solution of o-mercaptobenzoic acid previously degassed with nitrogen, a brown precipitate was formed immediately. Copper(II) was reduced to copper(I). Study of the complexes formed by univalent copper with disulphides<sup>16</sup> reveal the formation of the copper(I) complex of the corresponding disulphide.

When Fe(III) salt was added to a solution of o-mercaptobenzoic acid in the presence of dilute sulphuric acid, the solution immediately turned green and then bluish as more iron was

added, with the formation of a precipitate. Attempts to use this reaction for the titrimetric estimation of iron or o-mercaptobenzoic acid were not successful.

- Calvin, M. and Wilson, K., *J. Amer. Chem. Soc.*, 1945, **67**, 2003.
- Bjerrum, J., *Metal Ammine Formation in Aqueous Solution*, P. Haas and Son, Copenhagen, 1941.
- Leu-sing, D. L., *J. Amer. Chem. Soc.*, 1958, **80**, 4180.
- Fernando, Q. and Freiser, H., *Ibid.*, 1958, **80**, 4929.
- Cheney, G., Fernando, Q. and Freiser, H., *J. Phys. Chem.*, 1959, **63**, 2055.
- , Freiser, H. and Fernando, Q., *J. Amer. Chem. Soc.*, 1959, **81**, 2611.
- Corsino, A., Fernando, Q. and Freiser, H., *Anal. Chem.*, 1963, **35**, 1424.
- Allen, C. F. H. and Mackay, D. D., *Organic Syntheses, Collective Volume 2*, Edited by Blatt, A. H., John Wiley and Sons, Inc., New York, 1961 Ed., p. 580.
- Irving, H. and Williams, R. J. P., *J. Chem. Soc.*, 1953, p. 3192.
- Perrin, D. D., *Nature*, 1958, **182**, 741.
- Lumme, P. O., *Suomen Kemistilehti.*, 1958, **31 B**, 232; *Ibid.*, 1960, **33** (2), 25.
- Sidgwick, N. V., *J. Chem. Soc.*, 1941, p. 433.
- Larionov, S. V., Shul'man, V. M. and Podol'skaya, L. A., *Zh. Neorgan. Khim.*, 1964, **9** (10), 2333.
- Kumar, A. N. and Nigam, H. L., *Ind. J. Chem.*, 1967, **5**, 48.
- , and Katyal, M., *J. Prakt. Chem.*, 1966, **33** (3-4), 160.
- Hemmerich, P., Beinert, H. and Vanngard, J., *Angew. Chem.*, 1966, **78**, 449.

## LETTERS TO THE EDITOR

FORCE CONSTANTS AND  
THERMODYNAMIC PROPERTIES OF  
GERMYL ACETYLENE

RECENTLY Lovejoy and Baker<sup>1</sup> have investigated the infrared absorption spectra of  $\text{GeH}_3\text{CCH}$  and  $\text{GeD}_3\text{CCH}$  molecules and have assigned their fundamental frequencies. These molecules have  $C_{2v}$  symmetry and there are 10 fundamental frequencies of which 5 belong to the non-degenerate  $A_1$  type vibration and 5 belong to the doubly degenerate  $E$  type vibration. In the present note, we report the force constants and thermodynamic properties of these molecules. The FG matrix elements and the symmetry co-ordinates used in this investigation are the same as those used by Meister<sup>2</sup> for  $\text{CH}_3\text{CCH}$ . As there are 13 force constants in the general valence force field and only 10 frequencies, the values for  $K_\alpha$ ,  $K_\beta$  and  $K_\theta$  have been transferred from the previous work<sup>2</sup> on  $\text{CH}_3\text{CCH}$  and those for  $K_{ca}$  and  $K_{cf}$  have been transferred from  $\text{GeH}_3\text{CH}^3$ . The interbond distances Ge-H, Ge-D and Ge-C are the same as those for  $\text{GeH}_3\text{CN}$ . The  $\text{C}\equiv\text{C}$  and C-H distances are taken from the data on  $\text{CH}_3\text{CCH}$ . The calculated force constants and frequencies for  $\text{GeH}_3\text{CCH}$  are given in Tables I and II. The calculated frequencies are in reasonable agreement with the observed values.

TABLE I

Frequencies for  $\text{GeH}_3\text{CCH}$  and  $\text{GeD}_3\text{CCH}$ 

Frequency	$\text{GeH}_3\text{CCH}$		$\text{GeD}_3\text{CCH}$	
	Obs. $\text{cm}^{-1}$	Cal. $\text{cm}^{-1}$	Obs. $\text{cm}^{-1}$	Cal. $\text{cm}^{-1}$
$\nu_1$	3313.5	3313	3316.5	3316
$\nu_2$	2120	2120	1525	1525
$\nu_3$	2060	2060	2052.5	2053
$\nu_4$	843.8	843.8	608	608
$\nu_5$	530	530	518	518
$\nu_6$	2117	2134	1523	1545
$\nu_7$	886	886	643.2	643.0
$\nu_8$	673	673	673	673
$\nu_9$	643	643	484	484
$\nu_{10}$	216.4	216.4	202.8	202

The thermodynamic properties have been calculated assuming a rigid rotator harmonic oscillator model. The calculations have been made for a range of temperatures from 200 to 1000°K and the results are given in Tables III and IV. The authors are thankful to

TABLE II

Force constant for  $\text{GeH}_3\text{CCH}$  and  $\text{GeD}_3\text{CCH}$ 

Force constant $10^5$ dynes/cm.	$\text{GeH}_3\text{CCH}$	$\text{GeD}_3\text{CCH}$
$K_h$	2.656	2.773
$K_\sigma$	6.014	6.014
$K_\alpha^*$	15.799	15.799
$K_{ca}$	1.598	1.829
$K_c$	1.663	1.845
$K_\alpha^*$	0.1751	0.1751
$K_{\alpha\beta}$	-0.0435	-0.880
$K_\beta$	0.2172	0.2219
$K_\psi$	0.2524	0.2449
$K_\theta$	0.1897	0.1897
$K_{\psi\theta}$	0.0247	0.0247
$K_{ca}^*$	0.2417	0.2417
$K_{c\beta}^*$	0.1870	0.1870

Values marked by asterisk have been noted from previous work.

TABLE III

Heat content free energy, entropy and heat  
capacity at different temperatures  
Thermodynamic properties of  $\text{GeH}_3\text{CCH}$ 

Temp. (°K)	$(H^\circ - E_0)/T$	$-(F^\circ - E_0)/T$	S	$C_v$
200	10.4203	50.6801	61.1004	11.4734
300	12.2333	54.6198	66.8531	16.3705
400	14.0621	57.7942	71.8563	19.2586
500	15.9858	60.5737	76.5595	21.9682
600	17.3859	63.0431	80.4290	23.1780
700	18.6815	65.3873	84.0688	25.2538
800	19.7752	67.5131	87.2884	26.6533
900	20.9067	69.4707	90.3774	27.7460
1000	21.8355	71.4414	93.2769	28.7754

TABLE IV

Thermodynamic properties of  $\text{GeD}_3\text{CCH}$ 

Temp. K	$(H - E_0)/T$	$-(F^\circ - E_0)/T$	S	$C_v$
200	10.8326	51.5777	62.4103	13.8607
300	13.2823	55.0227	68.3050	16.5324
400	15.5523	58.4505	74.0018	21.6605
500	17.4312	61.4512	78.8824	24.0836
600	19.0819	64.6690	83.7509	25.8576
700	20.3481	66.7211	87.0692	27.2760
800	21.7027	69.1285	90.8312	28.7615
900	22.7720	71.3571	94.1291	29.5266
1000	23.6733	73.4384	97.1116	30.4859

T is the temperature in degrees Kelvin. The other quantities are in cal. deg.<sup>-1</sup> mole<sup>-1</sup> and  $E_0$  is the energy of one mole of perfect gas at absolute zero temperature.

Prof. N. L. Singh for his interest. One of us (D. V. R. A. Rao) is thankful to C.S.I.R. for financial assistance.

Dept. of Spectroscopy, (Miss) D. V. R. A. RAO.  
Banaras Hindu Univ., D. K. RAI.  
Varanasi-5, November 4, 1967.

1. Lovejoy, R. W. and Baker, D. R., *J. Chem. Phys.*, 1967, **46**, 638.
2. Meister, A. G., *Ibid.*, 1948, **16**, 950.
3. Krishna Pillai, M. G. and Perumal, A., *Bull. Soc. Chim. Belg.*, 1964, **73**, 29.

### K-CONVERSION COEFFICIENT OF 279 keV LEVEL IN Tl-203

A NEW method that depends on the measurement of the ratio of the intensities of the K-shell X-rays which follow internal conversion and the K-shell X-rays that are emitted when a target of suitable Z-value is irradiated with gamma-rays competing the internal conversions has been developed to determine the K-conversion coefficient. This method, though indirect, is not only simpler giving results of accuracy comparable with the existing methods but also avoids the use of expensive equipment, e.g.,  $\beta$ -ray spectrometer. In this letter we describe the use of this method to determine the K-conversion coefficient of the well-known 279 keV level in Tl-203. Hg-203 decays by  $\beta$ -emission to 279 keV level in Tl-203 which de-excites to ground state either by  $\gamma$  emission or internal conversion. A thin target of lead was irradiated by 279 keV gamma-rays from a 200 cm. source of Hg-203 and the K-shell X-rays of weighted mean energy 76.7 keV which were emitted from the target were counted under the photopeak by a  $1'' \times 1''$  NaI (Tl) scintillation spectrometer using the method described earlier.<sup>1</sup> The number of K-shell X-rays counted per unit time is given by the relation:

$$N_K(Pb) = \frac{S_1}{4\pi} \omega_1 \epsilon_K(Pb) \omega_K(Pb) A_K(Pb) \beta_K(Pb) \omega_2 n t_{eff}. \quad (1)$$

where  $S_1$  is the source strength,  $\omega_1$  and  $\omega_2$  are the source-target and target-detector solid angles respectively,  $n$ , the number of target atoms per c.c.,  $\sigma$  the cross-section for the production of K-shell X-rays when lead is irradiated with 279-keV gamma-rays,<sup>2</sup>  $t_{eff}$ , the effective thickness of the target and factor  $\epsilon_K \omega_K A_K \beta_K$  has been discussed in an earlier communication.<sup>3</sup> The subscript Pb means that the terms relate to lead X-rays.

The target was then replaced by a weak Hg-203 source of strength  $S_2$  and the K-shell X-rays that follow K-conversion were measured under the photopeak with the above spectrometer. The number of  $\gamma$ -rays from the small source  $S_2$  under the photopeak is given by

$$N_\gamma(Tl) = \frac{S_2}{4\pi} \omega_2 \epsilon_\gamma(Tl) A_\gamma(Tl) \quad (2)$$

and the K-conversion coefficient  $a_K$  is defined as

$$a_K = \frac{N_K(Tl) \epsilon_\gamma(Tl) A_\gamma(Tl)}{N_\gamma(Tl) \omega_K(Tl) \epsilon_K(Tl) A_K(Tl) \beta_K(Tl)} \quad (3)$$

where the various terms have their usual meaning. Since in the Z region involved in the present measurement the factor  $\omega_K \epsilon_K A_K \beta_K$  varies less than 0.5% we may put

$$\begin{aligned} \omega_K(Pb) \epsilon_K(Pb) A_K(Pb) \beta_K(Pb) \\ = \omega_K(Tl) \epsilon_K(Tl) A_K(Tl) \beta_K(Tl) \end{aligned}$$

Combining 1, 2 and 3,

$$a_K = \frac{N_K(Tl) S_1}{N_K(Pb) S_2} \omega_1 \sigma n t_{eff}. \quad (4)$$

The value of the ratio  $(N_K(Tl))/(N_K(Pb))$  was determined with an accuracy of better than 3% in fifteen independent runs.  $S_1/S_2$  was determined in a separate experiment with an accuracy of better than 1.5% by comparing the number of counts under the  $\gamma$ -ray photopeaks. Two intermediate sources had to be used to avoid the corrections due to geometry,  $\omega_1$  was calculated from the geometry of experimental set-up.  $n$  was calculated from the dimensions of the target.  $\sigma$  was extrapolated from the tables of Pratt *et al.*<sup>4</sup> Correction due to absorption of incident gamma-rays and emitted X-rays in the target was determined experimentally by using the targets of thickness  $t$ ,  $2t$ ,  $4t$ , etc., as explained earlier.<sup>5</sup> The value of  $a_K$  was found to be  $156 \pm 0.07$  which compares favourably with the previously determined values by other methods.

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B. S. SOOD.

1. Ghuman, B. S., Anand, S and Sood, B. S., *Curr. Sci.*, 1966, **35**, 540.
2. —, — and —, *Indian J. Pure Appl. Phys.*, 1967, **5**, 70.
3. —, — and —, *Curr. Sci.*, 1967, **36**, 484.
4. Pratts, R. H., Levee, R. D., Pexton, R. L. and Walter Aron, *Phys. Rev.*, 1964, **898 A**, 134.
5. Shute, G. G. and Sood, B. S., *Proc. Roy. Soc.*, London, 1960, **227 A**, 52.

# DIMER FORMATION IN ERYTHROSIN AND ROSE BENGAL PART II

At higher concentrations of the dye in solution, the absorption and the fluorescence spectra of Erythrosin and Rose Bengal show a new peak.<sup>1</sup> The peak was interpreted by us as due to dimer formation.<sup>1</sup> Similar results are obtained for Eosin as well.<sup>2</sup> In this note we have calculated the dimer peak, on Kasha's lines<sup>3</sup> which gives a direct quantitative proof for the dimer formation.

For a parallel long chain dimer, resulting from dipole-dipole interaction, the energy level shift ( $\xi$ ) is given<sup>3</sup> by the expression

$$\xi = \frac{M^2}{r^3} \quad (1)$$

where  $M$  is the transition moment in e.s.u. and  $r$  is the point-dipole, point-dipole distance and may be taken as the distance between the centres of gravity of the two molecules.

Making use of the relation between the oscillator strength ( $f$ ), and the transition moment,

$$f = 4.704 \cdot 10^{29} \cdot \nu \cdot M^2 \quad (2)$$

where  $\nu$  is the wave number of the maximum of monomer absorption (1) becomes

$$\xi = \frac{f}{4.704 \cdot 10^{29} \cdot \nu \cdot r^3} \quad (3)$$

The oscillator strength,  $f$ , can be calculated from

$$f = 4.315 \cdot 10^{-18} \cdot \int \epsilon \cdot d\bar{\nu} \quad (4)$$

where  $\int \epsilon \cdot d\bar{\nu}$  will be determined from the area of the plot, absorption coefficient ( $\epsilon$ ) against  $\bar{\nu}$ , for the first absorption band; the limits of integration can be found from a plot of the polarization of fluorescence against the exciting wavelength.<sup>4</sup>

For Erythrosin and Rose Bengal we find that  $f \sim 0.42$  and  $0.39$  respectively and  $\nu$  is  $19530 \text{ cm}^{-1}$  and  $18800 \text{ cm}^{-1}$  respectively. The value of  $r$  can be taken as  $6 \text{ \AA}$  for both Erythrosin and Rose Bengal. The difference between the monomer and dimer peaks is calculated from (3). Table I shows the calculated differences between the monomer

TABLE I

	$\nu \text{ cm}^{-1}$ calculated	$\nu_{\text{mon}} \text{ cm}^{-1}$	$\nu_{\text{dimer}} \text{ cm}^{-1}$
Erythrosin	1070	1300	950
Rose Bengal	1020	1320	980

and the dimer peaks of Erythrosin and Rose Bengal along with the observed values from

absorption ( $\Delta\nu_{ab}$ ) and fluorescence ( $\Delta\nu_{fl}$ ) spectra.<sup>1</sup> It is seen that the calculated and the observed differences are of the same order.

However, it is seen that for both Erythrosin and Rose Bengal the observed difference in monomer and dimer peaks in the fluorescence spectra is less than that observed in the absorption spectra. This may be due to either the dimers in the ground state being in the card packed form with somewhat oblique dipole moments in the excited state of the two monomers, or to the dipole moment of the dye molecule in the excited state being less than that in the ground state.

We are thankful to Dr. D. D. Pant for useful discussions.

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University of Delhi,  
Delhi-7, October 25, 1967. S. S. RATHI,  
K. GOPALAKRISHNAN,  
J. KEMHORE,  
M. K. MACHWE.

1. Machwe, M. K., Kishore, J., Gopalakrishnan, K. and Rathi, S. S., *Chem. Sci.*, 1967, **36**, 261 (referred to as Part I).
2. Rathi, S. S. and Machwe, M. K., To be published in *Acta Phys.* **23** (4).
3. McRae, E. G. and Kasha, M., *Physical Processes in Radiation Biology*, Edited by Augenstein, Leroy et al., Academic Press, Inc., New York, 1964, p. 23.
4. Pringsheim, P., *Fluorescence and Phosphorescence*, Interscience Publishers, Inc., New York, 1949, p. 381.
5. Sheppard, S. E., *Rev. Mod. Phys.*, 1942, **14**, 303.

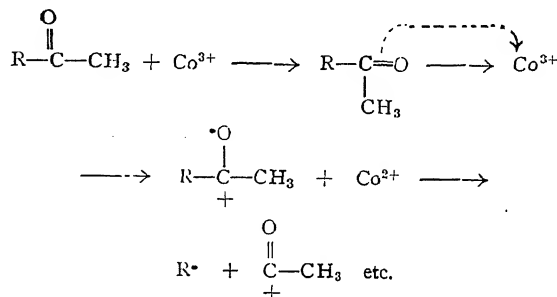
## OXIDATION OF SOME ORGANIC COMPOUNDS BY COBALTIC ION

Oxidation kinetics of various organic substrates<sup>1-4</sup> by cobaltic ion have been well established, the oxidation studies being confined mainly to  $\text{HClO}_4$  medium. We now report our results on the kinetics of oxidation of acetone, ethyl methyl ketone, *n* propyl methyl ketone and *n*-butyl methyl ketone by cobaltic nitrate in  $\text{HNO}_3$  medium; malonic acid, adipic acid, crotonic acid, diglycolic acid, dioxane, benzyl alcohol and ethylene glycol by cobaltic sulphate in  $\text{H}_2\text{SO}_4$  medium and itaconic acid by cobaltic perchlorate in  $\text{HClO}_4$  medium. Ethyl methyl ketone was studied in the three acid media,  $\text{HClO}_4$ ,  $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$  and dioxane in  $\text{HClO}_4$  and  $\text{H}_2\text{SO}_4$  to compare the relative rates of oxidation in the various media.

Cobaltic salts have been prepared as described earlier.<sup>5</sup> All the substrates used were of analar grade. Other reagents like ceric ammonium sulphate or nitrate,  $\text{NaHSO}_4$  or  $\text{KHSO}_4$ ,  $\text{NaNO}_3$ ,  $\text{NaOH}$ , etc., were all analar products.  $\text{NaClO}_4$  (4M) was used for adjustment of ionic strengths,

We report the following results: (a) All the reactions were found to be second order, first order each in  $[\text{Co}^{3+}]$  and  $[\text{substrate}]$ . The second order rate constant for acetone and malonic acid conforms to  $k_2 = b/[\text{H}^+]$  while for the rest of the substrates,  $k_2 = a + b/[\text{H}^+]$  ( $a$  and  $b$  have different values for different substrates). Rate constants, rate parameters, etc., for all the substrates appear in Table I. (b) Plots of  $\log k_{\text{obs.}}$  vs.  $\text{H}_0$  were linear at higher values of  $\text{H}_0$  and curves at lower values and slopes of the linear portions were not unity.

ketone  $\approx$  ethyl methyl ketone. Positive  $\Delta S$ ,  $\Delta E$  (21–30 K. cal. mole<sup>-1</sup>) and high temperature coefficients (3–7) for all ketones and other substrates are characteristics of reactions involving cobaltic oxidations. Mechanism of oxidation of ketones<sup>7</sup> may be explained on the basis of extensive degradation:



(ii) Rates of oxidation of acids increase in the order, crotonic < adipic < malonic  $\ll$  diglycolic acid. For all acids except diglycolic acid electron transfer from  $\text{-COOH}$  to  $\text{Co}^{3+}$  is probable:

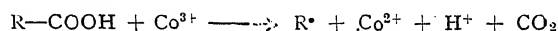


TABLE I

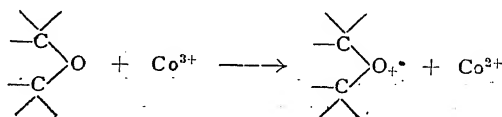
$[\text{Co}^{3+}] = 10^{-4}$  to  $10^{-3}$  M,  $[\text{Substrate}] = 10^{-3}$  to  $10^{-1}$  M and  $T = 15 \pm 0.1^\circ \text{C}$ .

Substrate		Medium	Rate parameters $k_2 \times 10^3$ , l.m. <sup>-1</sup> sec. <sup>-1</sup>	$\Delta E$ K.cal. mole <sup>-1</sup>	$\Delta S^*$ 288° K.	$\mu$ and $[H^+]$
Acetone	..	HNO <sub>2</sub>	0.6094	22	4.5	} $[H^+] = 1$ M and $\mu = 1.2$ M
Ethyl methyl ketone	..	HClO <sub>4</sub>	7.352	22	7.9	
"	..	HNO <sub>3</sub>	6.333	21	3.1	
"	..	H <sub>2</sub> SO <sub>4</sub>	3.000	27	24.0	
n-Propyl methyl ketone	..	HNO <sub>3</sub>	5.953	21	3.5	
Isobutyl methyl ketone	..	HNO <sub>3</sub>	1.340	25	16.2	
Crotonic acid	..	H <sub>2</sub> SO <sub>4</sub>	1.537	30	34.5	} $[H^+] = 2$ M and $\mu = 2.1$ M
Itaconic acid	..	HClO <sub>4</sub>	38.79	30	38.3	
Dioxane	..	H <sub>2</sub> SO <sub>4</sub>	18.71	23	13.0	
"	..	HClO <sub>4</sub>	22.43	26	23.3	
Malonic acid	..	H <sub>2</sub> SO <sub>4</sub>	31.75	30	38.2	
Adipic acid	..	H <sub>2</sub> SO <sub>4</sub>	2.636	34	48.8	
Diglycolic acid	..	H <sub>2</sub> SO <sub>4</sub>	421	27	33.6	} $[H^+] = 2$ M and $\mu = 2.1$ M
Benzyl alcohol	..	H <sub>2</sub> SO <sub>4</sub>	375	27	35.8	
Ethylene glycol	..	H <sub>2</sub> SO <sub>4</sub>	188.9	28	35.0	

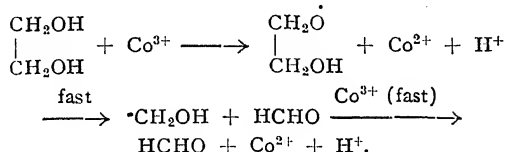
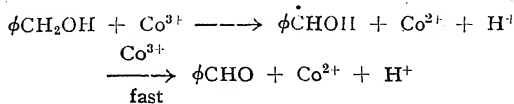
\* Standard state chosen for  $\Delta S$  is one mole. litre<sup>-1</sup>.

We conclude (i) that the keto forms of the ketones are active since oxidation rates  $\gg$  rates of enolisation.<sup>6</sup> High spin hydrolytic product,  $\text{CoOH}^{2+}$  is the active species for acetone while for the rest of the ketones both  $\text{Co}^{+3}_{(\text{aq})}$  and  $\text{Co}(\text{OH})^{2+}$  are the active species. The rate constants increase in the order, acetone  $<$  isobutyl methyl ketone  $<$  *n*-propyl methyl

while for diglycolic acid as well as dioxane high rates are probably due to attack of  $\text{Co}^{3+}$  on the ethereal oxygen:



(iii) Benzyl alcohol is oxidised twice as fast as ethylene glycol<sup>8</sup> and the oxidative paths may be



The attack might as well be on  $\alpha$ -C-H instead of on O-H.

(iv) Relative rates of oxidation increase in the order,  $\text{H}_2\text{SO}_4 < \text{HNO}_3 < \text{HClO}_4$ .

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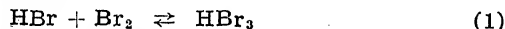
A. MEENAKSHI.  
M. SANTAPPA.

University of Madras,  
Madras-25, November 3, 1967.

1. Waters, W. A. and Littler, J., *Oxidn. Org. Chem.*, 1965, p. 216.
2. Cooper, T. A., Clifford, A. A., Mills, D. J. and Waters, W. A., *J. Chem. Soc. (B)*, 1966, p. 793.
3. — and Waters, W. A., *Ibid.*, 1967, p. 455.
4. Wells, C. F., *Trans. Faraday Soc.*, 1967, **63**, 156.
5. Jijie, K., Santappa, M. and Mahadevan, V., *J. Poly. Sci., A*, 1966, p. 378.
6. Dawson and Ark, *J. Chem. Soc.*, 1911, p. 1742.
7. Hoare, D. G. and Waters, W. A., *Ibid.*, 1962, p. 975.
8. Bawn, C. E. H. and Sharp, J. A., *Ibid.*, 1957, p. 1865.

## THE KINETICS OF THE BROMINATION OF AROMATIC COMPOUNDS—PART IV

ONE of the products in aromatic bromine substitution is hydrogen bromide. It was reported by Robertson and co-workers<sup>1</sup> that, in acetic acid medium, the hydrogen bromide inhibited the reaction by forming a complex with bromine, as follows:



Keefer, Ottenberg and Andrews,<sup>2</sup> who studied the kinetics of the mesitylene-bromine reaction in acetic acid, did not observe any such inhibition even when the reaction was carried out to more than 75% conversion. This communication contains our experimental findings regarding the role of hydrogen bromide in aromatic bromination in dry acetic acid medium.

Experiments were conducted under two different conditions, namely, (i) with equimolar initial concentration of the reactants (aromatic substrate and bromine) and (ii) with the sub-

strate present in a large amount compared to the bromine. In both cases the reaction was carried out up to about 80% conversion. In the first case, the reaction obeys third order kinetics<sup>3</sup> and therefore

$$-\frac{d[\text{Br}_2]}{dt} = k_3 [\text{ArH}][\text{Br}_2]^2 \quad (2)$$

and the integrated equation is

$$k_3 = \frac{1}{2t} \left\{ \frac{1}{(a-x)^2} - \frac{1}{a^2} \right\} \quad (3)$$

where  $a$  and  $(a-x)$  denote, respectively, the concentrations of bromine present initially and after a time interval  $t$ ,  $k_3$  is the third order rate constant and  $\text{ArH}$  denotes the aromatic compound. In the second case the reaction is pseudo-second order with respect to bromine<sup>3</sup> and therefore

$$-\frac{d[\text{Br}_2]}{dt} = k_2' [\text{Br}_2]^2 \quad (4)$$

and the integrated equation is

$$k_2' = \frac{1}{t} \left\{ \frac{1}{(a-x)} - \frac{1}{a} \right\}, \quad (5)$$

where  $k_2'$  is a pseudo-second order rate constant.<sup>3</sup>

Figure 1† shows plots for third order kinetics, using equation (3) in the appropriate

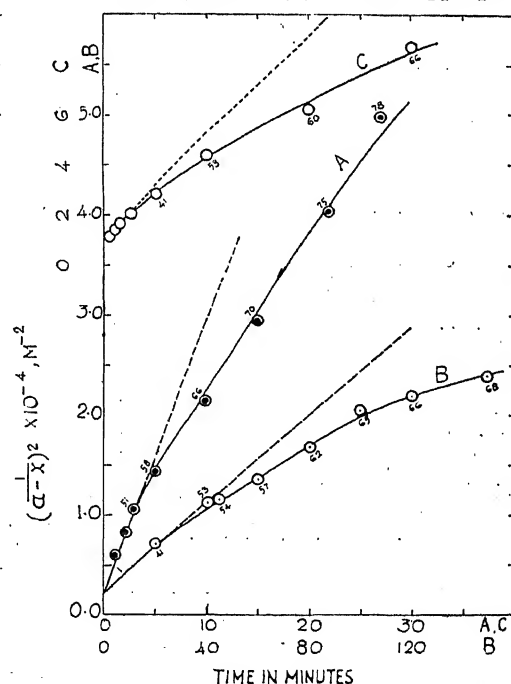


FIG. 1. Plots for overall third order kinetics in acetic acid at 30°C.; A, anisole-bromine reaction,  $[\text{ArH}]_0 = [\text{Br}_2]_0 = 0.02 \text{ M}$ ; B, paradimethoxybenzene-bromine reaction,  $[\text{ArH}]_0 = [\text{Br}_2]_0 = 0.02 \text{ M}$ ; C, anisole-bromine reaction,  $[\text{ArH}]_0 = [\text{Br}_2]_0 = 0.01 \text{ M}$ .

form. The figure near each point on the graph indicates the percentage conversion. The plots are linear only up to about 50% conversion and beyond that stage the shape of the curves indicates that the values of  $k_3$  decrease with time and that the reaction is inhibited by hydrogen bromide, as suggested by Robertson *et al.*<sup>1</sup>

Figure 2† shows plots for pseudo-second order kinetics, using equation (5) in the appropriate form. The plots are linear even up to about 80% conversion and therefore, no inhibition by HBr is indicated.

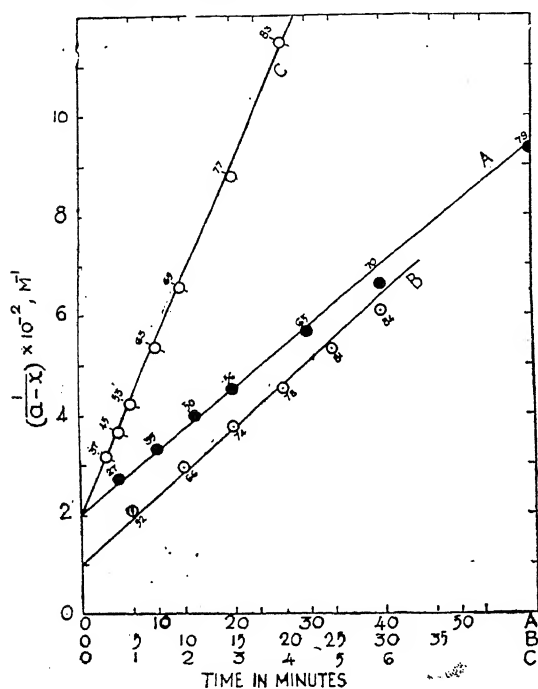


FIG. 2. Plots showing pseudo-second order kinetics with respect to bromine in acetic acid at 30°C.; A, para-dimethoxybenzene-bromine reaction,  $[\text{ArH}]_0 = 0.1 \text{ M}$ ,  $[\text{Br}_2]_0 = 0.005 \text{ M}$ ; B, para-dimethoxybenzene-bromine reaction,  $[\text{ArH}]_0 = 0.2 \text{ M}$ ,  $[\text{Br}_2]_0 = 0.01 \text{ M}$ ; C, anisole-bromine reaction,  $[\text{ArH}]_0 = 0.1 \text{ M}$ ,  $[\text{Br}_2]_0 = 0.005 \text{ M}$ .

If the reaction is retarded by the formation of  $\text{HBr}_3$ , then the shape of the lines in Fig. 2 should be similar to that in Fig. 1. Since our experimental finding is different, we have to conclude that the reaction is inhibited not by the formation of  $\text{HBr}_3$  but due to some other reason. We propose the following explanation. The aromatic compound and hydrogen bromide form a  $\pi$ -complex which has the probable composition  $\text{ArH} \cdot \text{HBr}$ . When the concentrations of the reactants are equal (Fig. 1), a substantial amount of the aromatic compound is converted

into  $\text{ArH} \cdot \text{HBr}$  (especially after about 50% conversion) and  $[\text{ArH}]$ , available for the reaction, decreases. Hence, the rate constant also decreases with time. When the aromatic substrate is present in a large amount (Fig. 2), the formation of  $\text{ArH} \cdot \text{HBr}$  does not affect  $[\text{ArH}]$  in the reaction system, even when there is cent per cent. conversion. No inhibition is, therefore, observed.

Both hydrogen bromide and bromine form  $\pi$ -complexes with aromatic molecules.<sup>4</sup> Since HBr is more polar than  $\text{Br}_2$ , the complex  $\text{ArH} \cdot \text{HBr}$  will be more easily formed than  $\text{ArH} \cdot \text{Br}_2$ . Hydrogen bromide is dissociated to a small extent in acetic acid<sup>5</sup>;  $\text{HBr} + \text{CH}_3 \text{COOH} \rightleftharpoons \text{CH}_3 \text{COOH}_2^+ + \text{Br}^-$ .  $\pi$ -Complexes such as  $\text{ArH} \cdot \text{CH}_3 \text{COOH}_2^+$  and  $\text{ArH} \cdot \text{H}^+$  may also be formed. They will affect the overall kinetics in the same manner as  $\text{ArH} \cdot \text{HBr}$ .

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\*  $k_2' = k_3 [\text{ArH}]$ .

†  $[\text{ArH}]_0$  and  $[\text{Br}_2]_0$  denote initial concentrations.

1. Robertson, P. W., De La Mare, P. B. D. and Johnston, W. T. G., *J. Chem. Soc.*, 1943, p. 276.
2. Keefer, R. M., Ottenberg, A. and Andrews, L. J., *J. Am. Chem. Soc.*, 1956, **78**, 255.
3. Seshadri, K. V. and Ganesan, R., *Curr. Sci.*, 1964, **33**, 366.
4. Andrews, L. J., *Chem. Rev.*, 1954, **54**, 713.
5. Glasstone, S. and Lewis, D., *Elements of Physical Chemistry*, Macmillan & Co. Ltd., London, 1960, p. 526.

## COMPOSITION AND STABILITY OF NICKEL-DIETHYLDITHIOCARBAMATE

Job's method<sup>1</sup> of continuous variation, the mole ratio method of Yoe and Jones<sup>2</sup> and the slope ratio method of Harvey and Manning<sup>3</sup> can be applied to determine the formula of the complex and its stability constant. In the present work, attempt has been made to determine the formula of the complex formed by nickel ions with sodium diethyldithiocarbamate ( $\text{NaDDC}$ ). The effect of pH on the stability of the complex is also studied.

### EXPERIMENTAL

The wavelength of maximum absorbance was determined by studying the absorbance of a mixture of cation and the chelating agent (in excess). It was 385 m $\mu$ .

For Job's method, different ml. of  $\text{NiCl}_2$  0.002 M was taken and to it varying amounts of 0.002 M NaDDC were added so as to have



the total mixture 2.5 ml. The complex being insoluble in water, 7.5 ml. ethyl alcohol was added to make it soluble and the alcohol content to be 75%. Exact half the concentrations were also employed.

For the slope ratio method, 0.002 M  $\text{NiCl}_2$  and 0.02 M NaDDC and 0.02 M  $\text{NiCl}_2$  and 0.002 M NaDDC were prepared. In one set, excess of NaDDC was taken and in the other, excess of  $\text{NiCl}_2$ . The alcohol percentage was 75.

For the mole ratio method, 0.002 M  $\text{NiCl}_2$  and 0.002 M NaDDC were prepared. To a fixed amount of  $\text{NiCl}_2$ , different amounts of NaDDC were added. Ethyl alcohol content was 75%. Experiments were repeated with exactly half the concentrations.

The data with all the three methods are not given for the sake of brevity.

For the study of stability of the complex at various pH, the absorbance of the mixtures with different buffers was measured at zero and twenty-four hours.

The results are shown graphically (Fig. 1).

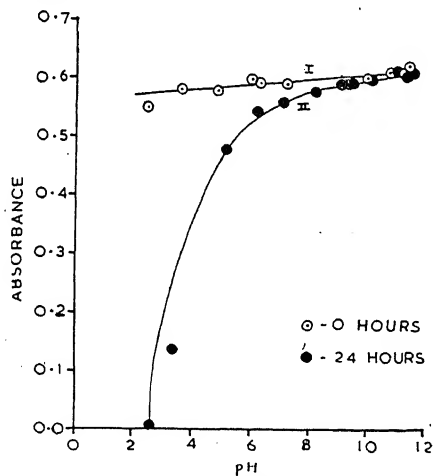


FIG. 1. Effect of pH on stability of  $\text{Ni}(\text{OOC})_2$ .

#### DISCUSSION

It was observed that the optical density was maximum for the mixture having the cation and NaDDC in the ratio 1 : 2. Thus, Job's method gave the formula  $\text{Ni}(\text{DDC})_2$ .

The slopes of the graphs were 0.448/0.4 and 0.220/0.4. According to the method of slope ratio, the ratio of two slopes was nearly equal to 1 : 2. Thus this method also gave the formula of the complex as  $\text{Ni}(\text{DDC})_2$ .

Mole ratio method showed a good break when the concentration ratio of the metal ion to NaDDC was 1 : 2. Hence, this method also gives the formula as  $\text{Ni}(\text{DDC})_2$ .

As regards the effect of pH on stability, it is found that the complex is stable down to pH 6, below which it is unstable (Fig. 1).

None of the methods was successful for the calculation of stability constants. This may be due to (i) very low solubility of the complex even in 75% ethyl alcohol, (ii) very high stability of the complex and (iii) decomposition of the complex at lower pH.

Thanks are due to Dr. A. M. Trivedi for interest in the work and to Dr. R. D. Desai for the laboratory facilities.

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1. Job, *Ann. Chim.*, 1928, 9 (10), 113; *Ibid.*, 1936, 6 (11), 97; *Vide* Martell and Calvin, *Chemistry of Metal Chelate Compounds*, 1st Edition, Published by Prentice Hall Inc., N. J., 1956, p. 29.
2. Harvey and Manning, *J. Am. Chem. Soc.*, 1950, 72, 4488.
3. Yoe and Jones, *Ind. Eng. Chem. Anal. Ed.*, 1944, 16, 111.

#### COMPOSITION AND STABILITY OF METAL-1-(o-ARSONOPHENYLazo)-2-NAPHTHOL-3:6-DISULPHONIC ACID CHELATES OF TRIVALENT ALUMINIUM, GALLIUM AND INDIUM IN AQUEOUS SOLUTION

1-(o-ARSONOPHENYLazo)-2-naphthol-3 : 6-disulphonic acid (APANS) has been extensively used as a chelating agent in the determination of thorium<sup>1</sup> and of many other metals.<sup>2</sup> In spite of the large amount of work done on the chromogenic properties of the reagent, the composition and stability of metal chelates involving APANS, have not received sufficient attention. In the present communication the composition and stability of the trivalent aluminium, gallium and indium have been described. The compositions were determined and were found to be 1 : 2 (metal : ligand) in each case, by employing the method of continuous variations, the mole ratio and the slope ratio methods. The Al-APANS was studied at 530 m $\mu$  (pH 4.0), Ga-APANS at 520 m $\mu$  (pH 3.35) and In-APANS at 520 m $\mu$  (pH 3.5). By Vosburgh and Copper's method,<sup>3</sup>  $\lambda_{\text{max}}$  of the complexes were found to be 490 m $\mu$  for all the three

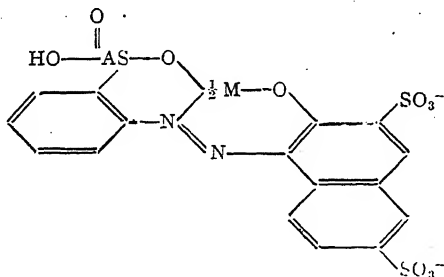
chelates.  $\lambda_{\max}$  of the APANS itself was found to be 480  $m\mu$  between (pH 3.5-4.0).

TABLE I  
Stability constants of chelates at 25° C.

Chelate	pH range of stability	pH of study	Log K	Method
Al-APANS	3.0-6.5	4.0	10.5±0.3	(a)
			9.6±0.1	(b)
			9.7±0.2	(c)
			10.3±0.3	(d)
Ga-APANS	3.0-6.0	3.5	9.9±0.4	(a)
			9.1±0.1	(b)
			9.5±0.2	(c)
			10.5±0.2	(d)
In-APANS	3.5-6.5	3.5	9.9±0.2	(a)
			9.1±0.1	(b)
			9.6±0.2	(c)
			10.3±0.1	(d)

Methods (a), (b), (c), and (d) correspond respectively to the method of Dey and co-workers, Job's method of continuous variations, Mole ratio, and Molar extinction method.

The following tentative structure is suggested for the aluminium (III), gallium (III) and indium (III) chelates of APANS.



[M stands for Al(III), Ga (III) and In(III)]

These are found to be anionic in nature by electrophoresis as well as by the complete adsorption of the chelates by ion exchange resin Amberlite IR-45 (OH). Further, on mixing the solutions of metal and the reagent, both brought individually to the same pH values, there is a drop in pH of the mixtures, showing that hydrogen ions are liberated as a result of the chelation process.

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Chemical Laboratories, V. C. GARG.  
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July 14, 1967.

- Adomovich, L. P. and Mirnaya, A. P., *Sovremennyye Metody Analiza V. Met Shornik*, 1955, p.172; Foreman, J. K., Riley, C. J. and Smith, T. D., *Analyt.*, 1957, 82, 89; Milner, G. W. C., Edwards, J. W. and Paddod, A., *Atomic Energy Estab. (Gt. Brit.) AERE/C/R*, 1958, 2612, 6; Thomason, P. F., *Anal. Chem.*, 1956, 28, 1527.
- Kuznetsov, V. E., *Doklady Akad. Nauk S.S.S.R.*, 1945, 50, 233.
- Vosburgh, W. C. and Cooper, G. R., *J. Am. Chem. Soc.*, 1941, 63, 437.

### STABILITY CONSTANTS OF THE SYSTEMS ZINC (II)- AND CADMIUM (II)-2:3-DIAMINO-2:3-DIMETHYL BUTANE

IN the present investigation stability constant of zinc (II)- and cadmium(II)-tetrameen (tetrameen is the abbreviation for the ligand) systems have been determined at 40, 30, 20, 10 and 0° C. and also at ionic strengths 0.1 M, 0.5 M and 1 M KNO<sub>3</sub> by pH-titration method.

Acid dissociation constants of tetrameen have been determined at the above-mentioned temperatures and ionic strengths. It was found from the titration curves (pH vs. V and  $\Delta\text{pH}/\Delta V$  vs. V) that the volumes of nitric acid required for the first half-neutralisation and second half-neutralisation of the diamine were in the ratio 1:2. It was also evident from the values that  $k_1$  and  $k_2$  differed by more than 100-fold. So the values of  $\text{pk}_1$  and  $\text{pk}_2$  were calculated according to the values of pH at the volumes of acid required for the first and second half-neutralisation of the diamine. The results are given in Table I.

TABLE I  
Acid dissociation constants of the tetrameen

Temperature °C.	Ionic strength M KNO <sub>3</sub>	$\text{pk}_2$	$\text{pk}_1$
40	1	9.75	6.30
	0.5	9.65	6.20
	0.1	9.54	6.10
30	1	9.90	6.50
	0.5	9.80	6.35
	0.1	9.70	6.25
20	1	10.18	6.70
	0.5	10.05	6.55
	0.1	9.88	6.40
10	1	10.55	7.10
	0.5	10.35	6.90
	0.1	10.18	6.70
0	1	10.80	7.30
	0.5	10.60	7.10
	0.1	10.40	6.90

As the ionic strength is increased there are greater number of nitrate ions present in the solution and hence the dissociation is depressed.

The higher the temperature, the greater is the dissociation and consequently the values of  $pk_1$  and  $pk_2$  are lower.

Stability constants were evaluated following the method of calculation of Basolo and Murmann.<sup>3</sup> From the curves of potentiometric titrations of zinc nitrate and cadmium nitrate with the tetrameen it was found that in either case the molar ratio of the metal ion and the diamine in the complex formed was 1:2. Hence stability constants were determined for the 'bis' complexes. Values of overall stability constants ( $\log \beta_2$ ) are given in Table II.

TABLE II  
Values of  $\log \beta_2$  of the zinc (II)- and cadmium(II)-tetrameen systems

	Temp. °C.	$\mu=0.1$ M KNO <sub>3</sub>	$\mu=0.5$ M KNO <sub>3</sub>	$\mu=1$ M KNO <sub>3</sub>
Zn II	40	10.76	11.20	11.60
	30	11.60	12.00	12.30
	20	12.24	12.95	13.20
	10	13.30	14.02	14.30
	0	14.08	14.80	15.20
Cd II	40	9.60	10.10	10.66
	30	10.44	10.90	11.40
	20	11.24	11.86	12.25
	10	11.94	12.80	12.86
	0	12.80	13.32	13.80

It is found that the values of  $\log \beta_2$  increase with the increase of ionic strength when the temperature is kept constant and decrease with the increase of temperature when the ionic strength is kept constant.

Correlation of the results of the present investigation with those of the previous workers suggests that the stability of metal tetrameen complexes decreases in the order  $\text{Cu} > \text{Ni} > \text{Zn} > \text{Cd}$  which holds good as a part of Mellor and Maley's order.<sup>4,5</sup>

Values of  $\log \beta_2$  of the zinc(II)-tetrameen system is found to be greater than that of cadmium(II)-tetrameen system; these are justified from the standpoint of 'ionic radii' and 'ionic potential'.

Values of some thermodynamic functions involved in the formation of complexes are given in Table III.

TABLE III  
Values of thermodynamic functions of the tetrameen complexes

M (II)	$\Delta G^\circ$ (K cal./mole)	$\Delta H^\circ$ (K cal./mole)	$\Delta S^\circ$ (cal./deg.)
Zn ..	1.4527	1.4494	0.
Cd ..	1.3938	1.2643	0.4

Small values of  $\Delta S^\circ$  for the complexes are due to the fact that the ligand tetrameen is uncharged and generally the chelate formation with an uncharged ligand is accompanied by a small positive value of  $\Delta S^\circ$ .

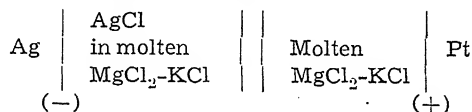
Dept. of Inorganic Chem., N. G. PODDER.  
Indian Association for the  
Cultivation of Science,  
Calcutta-32, July 7, 1967.

1. Basolo, F., Chen, Y. T. and Murmann, R. K. *J. Am. Chem. Soc.*, 1954, **76**, 956.
2. Martell, A. E. and Gutafson, R. L., *Ibid.*, 1959, **81**, 525.
3. Basolo, F. and Murmann, R. K., *Ibid.*, 1952, **74**, 5243.
4. Mellor and Maley, *Nature*, 1947, **159**, 370.
5. — and —, *Ibid.*, 1948, **161**, 436.

#### ON THE USE OF Pt FOIL AS REFERENCE ELECTRODE IN MOLTEN SALTS

In several voltammetric studies in molten salts a platinum foil dipping into the melt has been employed as a reference system<sup>1,2</sup> which is analogous to a mercury pool electrode in aqueous polarographic work. In the process of evaluation of the available decomposition potentials in molten chlorides using a platinum foil anode, it is necessary to have information on the stability and the depolarizability of such a system. In this communication this aspect is considered in molten  $\text{MgCl}_2$ -KCl (32.5:67.5 mole per cent.) at 475° C. used as a solvent.

The method of preparation of the solvent and the general experimental techniques and fused salt methodology have been described in detail elsewhere.<sup>3-5</sup> E.M.F. of the cell



on dipping the platinum foil electrode and over a 4-hour period was measured. The depolarizability of the system was also studied.

It is seen (Table I) that the cell e.m.f. increases continuously, changes being rapid initially but tending to level off after about 2 hours. Since the potential of the system  $\text{Ag}/\text{Ag(I)}$  has been shown<sup>4</sup> to be stable with time, these changes in cell e.m.f. were ascribed to changes in the potential of platinum foil dipping into the melt. The initial e.m.f. might arise from the small concentration of platinum ions at the surface of the electrode produced by corrosion,<sup>6</sup> or in presence of traces of mois-

ture<sup>7,8</sup> or oxygen in the melt platinum foil may be functioning as an oxygen electrode.<sup>9</sup> The initial abrupt changes are due to the absence of a depolarizing system.

TABLE I  
Stability of the cell e.m.f. with time

Time after introduction of Pt foil in the melt (minutes)	Cell e.m.f. (Volts)
0.0	0.0800
0.5	0.2000
1.0	0.4100
1.5	0.4700
2.5	0.4926
4.0	0.5170
5.0	0.5270
7.0	0.5390
10.0	0.5467
15.0	0.5524
53.0	0.5888
95.0	0.5980
110.0	0.5993
125.0	0.6023
150.0	0.6051
200.0	0.6120
240.0	0.6188

TABLE II  
Depolarizability of the Pt foil electrode

Current drawn between Pt foil electrode and PME ( $\mu$ A)	Pt foil potential vs. Ag (I)/Ag (Volts)
0.0	0.6188
1.0	0.6200
4.0	0.6205
7.5	0.6217
9.0	0.6235
12.0	0.6238
14.0	0.6240
17.5	0.6237
22.0	0.6230
0.0	0.6191
- 2.2	0.6186
- 4.0	0.6184
- 6.0	0.6179
- 7.0	0.6171
-11.0	0.6155
-13.0	0.6150
0.0	0.6224

Since platinum foil is the anode of the above cell, during the balancing of the potentiometer over 3-4 hours period more and more of Pt(II) is generated by anodic oxidation which gives some stability to this system. From the apparent standard electrode potential of Pt(II)-Pt(0) in this solvent (unpublished data of the authors), Pt(II) concentration corresponds to  $2.543 \times 10^{-7}$  moles. To determine the depolarizability of this after a 4-hour period, the platinum foil was made the anode in the voltammetric deposition of Cd from

CdCl<sub>2</sub> solution on a platinum microelectrode (PME). At different values of electrolytic current drawn between PME and Pt foil electrode, the potential of the latter vs. Ag(I)/Ag was monitored. Data in Table II show that the platinum foil electrode shows hysteresis and gets polarized to the extent of 8-9 millivolts.

It is thus concluded that a platinum foil dipping into the melt can neither function as stable nor as depolarized reference. The data obtained with such a reference are thus to be accepted with caution and are useful only on a relative basis.

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Department of Chemistry, H. C. GAUR.  
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- Hills, G. J., Oxley, J. E., and Turner, D. W., *Silicates Ind.*, 1961, **26**, 559.
- and Johnson, K. E., *Advances in Polarography, Proc. 2nd Intern. Congr.*, Cambridge, 1959, Pergamon Press, 1960, **3**, 974.
- Gaur, H. C. and Behl, W. K., *Electrochim. Acta*, 1963, **8**, 107.
- Behl, W. K., "Polarographic studies and standard electrode potential measurements in molten Magnesium chloride—Sodium chloride—Potassium chloride eutectic as solvent," *Ph.D. Thesis*, University of Delhi, 1962.
- Gaur, H. C. and Bhatia, B. B., *J. Sci. and Ind. Res.*, India, 1962, **21A**, 16.
- Fiorani, M., Bombi, G. G. and Mazzocchin, G. A., *J. Electroanal. Chem.*, 1967, **13**, 167.
- Burkhard, W. J. and Corbett, J. D., *J. Am. Chem. Soc.*, 1957, **79**, 6361.
- Duke, F. R. and Doan, A. S. Jr., *Iowa State College J. Sci.*, 1958, **32**, 451.
- Delimarskii, Yu. K. and Markov, B. F., *Electrochemistry of Fused Salts*, Government Scientific and Technical Publication on Heavy and Ferrous Metallurgy, Moscow, 1960, p. 176.

#### MECHANISM OF POTENTIATION OF CATECHOLAMINE RESPONSES AFTER ADRENERGIC BETA RECEPTOR BLOCKING DRUGS

ADRENERGIC beta receptor blocking drugs potentiate the pressor responses to catecholamines, in dogs. This is believed to be due to the abolition of vasodilatation (Shanks, 1966). The present work shows that potentiation of noradrenaline responses could also occur by the effect of adrenergic beta receptor blocking drugs on its uptake by tissue stores.

Thirty isolated vas deferens preparations were obtained from albino rats (150-200 gm.) and

suspended in oxygenated Krebs Henseleit solution at 33° C. The contractions were recorded with a gimbal lever giving 10 times magnification, on smoked paper.

Effects of adrenergic beta receptor blocking drugs, namely D(-) *n*-isopropyl-paranitrophenyl ethanolamine (l-INPEA; Selvi) and *n*-isopropyl- $\beta$  (4-methanesulphonamidophenyl) ethanolamine (MJ 1999; Mead Johnson and Co.) were studied on l-noradrenaline induced responses. Twelve vas deferens preparations were obtained from reserpinised rats (5 mg./kg. I.P. 48 and 24 hrs. prior to sacrifice), to study the effects of the adrenergic beta receptor blocking drugs on the uptake of noradrenaline.

MJ 1999 and l-INPEA (5  $\mu$ g./ml. in both cases), potentiated markedly the responses of noradrenaline on the vas deferens (Fig. 1). Repeated wash restored the original action of noradrenaline. The absence of adrenergic beta receptors, in rat vas deferens, was confirmed by failure of even high doses of l-isoprenaline (20  $\mu$ g./ml.) to produce a response.

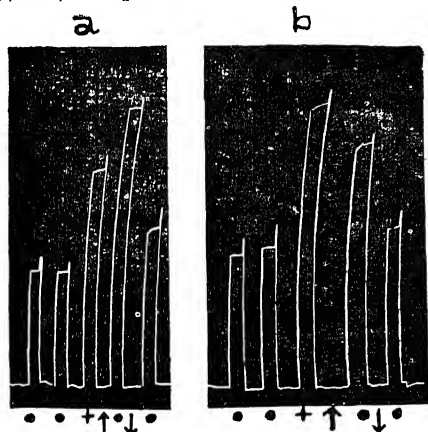


FIG. 1. *Isolated rat vas deferens*: Responses taken after l-noradrenaline (5  $\mu$ g./ml. at ● and 10  $\mu$ g./ml. at +). Adrenergic beta receptor blocking drug (5  $\mu$ g./ml.) added at ↓ and washed out at ↓. Left-hand panel (a) with l-INPEA and right-hand panel (b) with MJ 1999. Note greater potentiation of noradrenaline responses after l-INPEA.

On reserpinised preparations, tyramine (30  $\mu$ g./ml.) failed to produce a response which indicated depletion of endogenous catecholamine stores. Repletion of these stores by noradrenaline (5  $\mu$ g./ml.) for 20 minutes restored the response of the tissue to tyramine. This restoration was much less when repletion with noradrenaline was attempted in the presence of either MJ 1999 or l-INPEA (5  $\mu$ g./ml. each) (Fig. 2). It was therefore evident that these drugs prevented the uptake of noradrenaline by

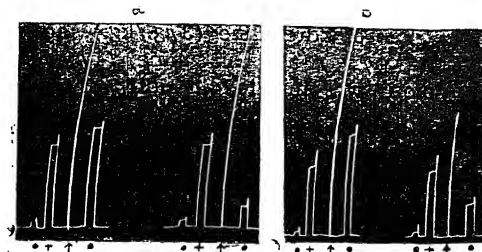


FIG. 2. *Isolated reserpinised rat vas deferens*: Showing responses to tyramine (30  $\mu$ g./ml.) at ● and l-noradrenaline (5  $\mu$ g./ml.) at +. Repletion of stores done for 20 minutes with noradrenaline (5  $\mu$ g./ml.) alone at ↑ and with noradrenaline in the presence of adrenergic beta receptor blocking drug (5  $\mu$ g./ml.) at ↓. Left-hand figure (a) shows reduction in noradrenaline uptake by l-INPEA and right-hand figure (b) shows that by MJ 1999. Note the greater inhibition after l-INPEA.

the stores which could be responsible for their ability to potentiate the action of noradrenaline.

Use of rat vas deferens, a tissue containing alpha receptors, predominantly, makes the above interpretation unequivocal.

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1. Shanks, R. G., *Brit. J. Pharmacol.*, 1966, 26, 322.

## EFFECT OF SOME ANTIBIOTICS ON CAT BLOOD PRESSURE AND RESPIRATION

STRETNIKOV<sup>1</sup> has demonstrated hypotensive effect of oxytetracycline in cats. Tesic and Stojarovic<sup>2</sup> have studied the effect of calciferol on neomycin induced changes on blood pressure. This communication deals with the study of effect of some common antibiotics on cat blood pressure and respiration.

Cats of either sex weighing between 2-3 kg. were used. Pentobarbitone sodium (40 mg./kg.) was administered intraperitoneally for anesthetising the cat. Trachea was cannulated and connected with Marey's tambour while blood pressure was recorded by cannulating the right carotid artery and connecting it to a manometer. The experiment started one hour after dissection of the cat. Initial blood pressure, heart and respiratory rates were recorded. Drugs were injected through the cannulated femoral vein and quantity of saline after each

injection was kept constant. After recording the responses of adrenaline (3 µg./kg.), acetylcholine (1 µg./kg.) and histamine (1 µg./kg.), the antibiotic was injected in doses of 10 µg./kg., 50 µg./kg. and 3 mg./kg. The responses of adrenaline, acetylcholine and histamine were repeated. Antibiotics used for the study were 6-aminopenicillanic acid (6-APA), neomycin (NM), ampicillin (AMP), paramomycin (PM), chlortetracycline (CTC) and chloramphenicol (CPL).

It was observed that 6-APA, AMP, PM, and CPL did not alter the heart rate, blood pressure and respiration. NM (3 mg./kg.) caused slight fall of blood pressure (about 10 mm. Hg) while there was no appreciable change in heart rate and respiration. CTC (3 mg./kg.) caused transient fall of blood pressure followed by increase in heart rate without affecting respiration. In 10 and 50 µg./kg. doses, NM and CTC had no effect.

The responses of adrenaline, acetylcholine and histamine were unaffected after administration of these antibiotics. Leaders *et al.*<sup>3</sup> have demonstrated that tetracycline and CPL antagonise the acetylcholine and histamine induced responses of rabbit ileum. However, this study indicates that 6-APA, NM, AMP, PM, CTC and CPL in the above doses, have neither potentiating nor antagonising action as regards adrenaline, acetylcholine and histamine induced responses on cat blood pressure and respiration.

The authors acknowledge the encouragement of Dr. M. J. Thirumalachar, Superintendent, Research, Hindustan Antibiotics Ltd., Pimpri, in this study.

Research Laboratory, B. G. VAD.  
Hindustan Antibiotics Ltd., I. NALINI.  
Pimpri, Poona-18, V. K. DESHMUKH.  
October 9, 1967.

1. Stretnikov, YnE., *Antibiotiki*, 1964, **9/3**, 258.
2. Tesic, C. and Stojarovic, M., *Archiv. Farm.* (Belgrade), 1962, **12** (6), 537.
3. Leaders, F., Pittinger, C. and Long, J. P., *Antibiot. and Chemotherapy*, 1960, **10**, 503.

### HENNELLYSPORITES, A NEW MIOSPORE GENUS FROM LOWER GONDWANA HORIZONS

THE miospores from Lower Gondwana deposits, hitherto described as *Retusotriletes* Naumova (1953), have been assigned to a new genus *Hennellysporites* gen. nov.

*Retusotriletes* was instituted by Naumova (1953) to accommodate some Devonian simple trilete miospores with an ill-defined to well-defined area *contigionis*. However, various species referred to *Retusotriletes* by Naumova (1953) show a wide range of sculpture varying from grana to bacula which indicate the heterogeneous association of morphographic characters in the genus (Potonié, 1953).

From the Upper Devonian of W. Australia, Balme and Hassell (1962) and Balme (1964) assigned some miospores to *Retusotriletes* Naum. Balme (1960) also reported similar spores in the Upper Carboniferous microfloras from N.W. Australia.

From the Lower Gondwana formations of Australia, Balme and Hennelly (1956) described some apparently similar miospores under the name *Calamospora diversiformis* Balme and Henn., which later on were transferred to *Retusotriletes* by Bharadwaj (1962, p. 79). A study of several specimens in the coals of Barakar stage has, however, revealed (Tiwari, 1965) that apart from area *contigionis* a small triangular area (15–20 µ in size) is generally present in the centre of the miospore. This defined area is denser than rest of the exine (see Tiwari, 1965, Pl. I, Figs. 6, 7; Bharadwaj and Tiwari, 1964, Pl. I, Fig. 6; Bharadwaj and Saluja, 1964, Pl. I, Fig. 18; Balme and Hennelly, 1965, Pl. II, Figs. 14–16; Balme, 1964, Pl. III, Fig. 2; Bharadwaj, 1966, Text-Fig. 12). The L-O analysis of *R. diversiformis* reveals that the "denser triangular area" is not an inner body, but it is a definite inter-ray thickening of the proximal exine. Similar conclusion is arrived at by examining a few laterally or semi-laterally flattened spores. The inter-ray thickening is a haptotypic character and hence a qualitatively important one.

These facts suggest that morphographically *R. diversiformis* does not find its place in the genus *Retusotriletes* Naum (1953).

### Hennellysporites GEN. NOV.

*Genotype*.—*Hennellysporites diversiformis* (Balme and Henn, 1966) comb. nov.

*Diagnosis*.—Miospores trilete, circular, sub-circular to broadly triangulo-circular; trilete rays simple, half to two-third spore radius long, exine lævigata; curvatures of area *contigionis* present; Proximally inter-ray thickening forming a denser area around trilete apex; *Extrema lineamenta* smooth.

*Description*.—The trilete rays are mostly straight with pointed ends; usually they are

equal in length but sometimes they are unequal. Labra are thin and the vertex is low. Y-mark is distinct close or open. The ray extends upto two-third of the spore radius, but is never seen reaching the margin. Exine is thin or thick, upto  $2\mu$  in optical section, laevigate but it may be indistinctly intrapunctate. The contact area is usually distinct; sometimes partly seen with semicircular wide *curvatures*; ridges are not prominent. Inter-ray thickening around proximal pole is denser than the rest of the surrounding area; it may be sharply defined or with merging boundary.

**Comparison.**—The closely comparable genus *Retusotriletes* differs from *Hennellysporites* in the absence of marked inter-ray thickening. *Retusotriletes* is found in much older beds of the northern hemisphere and includes heterogeneous morphographic units (Naumova, 1953). These facts also favour the separation of the two genera in question. *Calamospora* is distinguished from *Hennellysporites* by the bigger size-range, thinner folded exine and the absence of polar thickening.

*Hennellysporites diversiformis* (BALME AND HENN, 1956) COMB. NOV.

**Holotype**—Balme and Hennelly, 1956, Pl. 2, Fig. 14.

**Synonym**—*Calamospora diversiformis* Balme and Henn, 1956.

**Type Locality**—Main Greta Seam, Cessnock No. 1 Colliery, Greta Coal Measures, N.S.W.

**Diagnosis** (emend.)—Miospores circular to triangulo-circular; size-range  $24-50\mu$ ; Y-mark distinct, rays  $\pm 2/3$  radius long, simple but sharp; contact area wide, curvatures marked at least at the ray tips; polar thickening apparently subtriangular with merging outline,  $15-20\mu$  across; exine thin,  $1-2\mu$  in optical section.

**Remarks.**—Other specimens referable to this species are: Balme and Hennelly, 1956, Pl. II, Figs. 15-18; Bharadwaj, 1962, Pl. I, Figs. 9, 10; Tiwari, 1965, Pl. I, Figs. 6, 7.

*Hennellysporites indicus* SP. NOV.

**Holotype**—Bharadwaj and Tiwari, 1964, Pl. I, Fig. 6.

**Locus Typicus**—Korba Coalfield, Barakar Stage, Lower Gondwana, India.

**Diagnosis.**—Size-range  $25-50\mu$ ; rays very sharp, straight, usually  $\frac{1}{2}$  the radius long; contact area apparent; polar thickening sharply defined, triangular, extending upto ray ends; exine  $1-2\mu$  thick, laevigate.

**Comparison.**—*H. indicus* is distinguished from *H. diversiformis* by its shorter rays and sharply defined polar thickening.

**Remarks.**—Other specimens referable to this species are: Bharadwaj and Salujha, 1964, Pl. I, Fig. 18; Balme, 1964, Pl. 3, Fig. 2.

Birbal Sahni Institute of R. S. TIWARI.

Palaeobotany,  
Lucknow, September 20, 1967.

1. Balme, B. E., *IV<sup>e</sup> Internat. Congr. Carbonif. Stratigr. Geol.*, 1960, p. 25.
2. —, *Palaeobotanist*, 1960, 9, 1.
3. —, *Ancient Pacific Floras*, 1964, p. 49.
4. — and Hassell, C. W., *Microfossils*, 1962, p. 1.
5. — and Hennelly, J. P. F., *Aust. J. Bot.*, 1956, 4, 240.
6. Bharadwaj, D. C., *Palaeobotanist*, 1962, 9, 63.
7. —, *Symp. Florist Stratigr. Gondwanal.*, 1966, p. 69.
8. — and Salujha, S. K., *Palaeobotanist*, 1964, 12, 181.
9. — and Tiwari, R. S., *V<sup>e</sup> Internat. Congr. Carbonif. Stratigr. Geol.*, 1964, 3, 1131.
10. Potonié, R., *Geol. Jb.*, 31, Pt. II.
11. Naumova, S. N., *Trans. Inst. Sci. Acad. Sci. USSR*, 60, 202.
12. Tiwari, R. S., *Palaeobotanist*, 1965, 13, 168.

#### THE ELECTRIC CHARGE ON SARCOSOMES OF GASTROCNEMIUS MUSCLES OF FROG IN *VIVO* SYSTEM

The subcellular components were found to possess either a net positive or negative charge.<sup>1-4</sup> Similar studies on gastrocnemius muscle of frog<sup>5</sup> suggested that the enzymes such as succinate malate and glutamate dehydrogenases had higher activity in the cathode half (KH) and lesser in the anode half (AH) of the experimental muscle than the controls. As these enzymes were considered to be the specific markers for the sarcosomes,<sup>6</sup> it was presumed that these subcellular particles were migrating towards the cathode end of the experimental muscle, subjected to long axis voltage gradient.

The earlier observations were based on estimations of activity of these enzymes in the homogenates, whose rate of activity can be dependent on the concentration of cofactors and inorganic ions. To eliminate such interfering factors in the inferences, 0.25 M sucrose homogenates (10% wt./vol.) of both the control and experimental (AH and KH) muscle halves were dialyzed against sodium-potassium phosphate buffer of pH 6.8 (0.1 M) in cold for 3 hours. The level of succinate dehydrogenase activity in dialyzed extracts was higher in the KH, lesser in the AH than the control (Table I), showing a pattern similar to that observed

in non-dialyzed extracts (Table II). Since the possible influence of cofactors and inorganic ions was thus eliminated, variation in the levels of activity of the enzymes found in the experimental muscle halves refer directly to the differences in the quantity of enzyme in these halves.

TABLE I

*Succinate dehydrogenase activity in the dialyzed homogenates of control, AH and KH muscle halves at pH 7.0—studied by ferricyanide reduction method*

Enzyme activity is expressed in  $\Delta$  optical density/min.

Control	Experimental	
C	AH	KH
0.42 $\pm$ 0.08	0.27 $\pm$ 0.088	0.52 $\pm$ 0.028

TABLE II

*Succinate, malate and glutamate dehydrogenases activity at pH 7.0 in non-dialyzed homogenates of control and experimental muscle halves*

Enzyme activity is expressed in  $\mu$ g. Formazon/gm./hr.

S. No.	Enzyme	Control C	Experimental	
			AH	KH
1	Succinate dehydrogenase	122.70	68.25	193.22
2	Malate dehydrogenase	87.98	41.90	114.61
3	Glutamate dehydrogenase	306.95	267.20	324.70

The estimation of the level of succinate dehydrogenase activity in the presence of sodium malonate (0.5 ml. of 0.01 M sodium malonate per each ml. of the homogenate), a competitive inhibitor, indicated considerable drop in the enzyme activity in the sample with malonate (61.48  $\pm$  4.498  $\mu$ g. formazon/gm./hr.) over the normal sample (212.07  $\pm$  11.72  $\mu$ g. formazon/gm./hr.). This observation clearly indicated that the activity contributed by the enzyme in the incubation mixture, previously referred,<sup>5</sup> was specifically due to the activity of succinate dehydrogenase.

To obtain conclusive evidence, the sarcosomes were isolated from the control and experimental (AH and KH) muscle halves by differential centrifugation technique. 10% (wt./vol.) 0.25 M sucrose homogenates of control and experimental muscles were prepared at 0° C. and centrifuged at 1,000 g. for 20 min. in Beckmann Ultracentrifuge and the supernatants were obtained. These supernatants were again centrifuged at 16,000 g. for 20 min. in the same centrifuge. The sediments which formed the sarcosomal fraction of

control, AH and KH were repeatedly washed in 0.25 M sucrose solution and the protein content was estimated by Biuret method.<sup>7</sup> This sarcosomal protein content as estimated above was high in KH (1,750  $\mu$ g./gm.) and less in AH (1,160  $\mu$ g./gm.) than the control (1,580  $\mu$ g./gm.). As the sarcosomal protein content is an index of their bulk, it can be inferred that the sarcosomal concentration was higher in KH, lesser in AH than the control. Estimation of cytochrome C content in the control and experimental muscle halves was also in conformity with the present trend.<sup>5</sup>

The evidence obtained in the present study suggests that the sarcosomes possess a net positive charge within the muscle fibres and migrate towards the cathode in an electric field of direct current. The positive charge on the sarcosomes within the live muscle fibres could be one of the forces which attracts and lodges the negatively charged electrons facilitating the oxido-reduction reactions.

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University,  
Tirupathi (A.P.), S. India,  
September 25, 1967.

1. Dahl Gren, U., *Carnegie Inst. Wash. Publ.*, 1915, 212, 213.
2. Churney, L. and Klein, H. M., *Biol. Bull.*, 1937, 72, 384.
3. Heilbrunn, L. V. and Daugherty, K., *Physiol. Zool.*, 1939, 12, 1.
4. Tobias, J. M. and Solomon, S., *J. Cell. Comp. Physiol.*, 1950, 35, 1.
5. Govindappa, S. and Karumuri S. Swami, *Ind. J. Exptl. Biol.*, 1962, 3, 1.
6. De Duve Chr., Wattiaux, R. and Baudhuin, P., *Advances. Enzymol.*, 1962, 24, 291.
7. Glick, D., *Methods of Biochemical Analysis*, Interscience Publ., Inc., New York, 1954, 1.

### THE MEAN POSITION OF FIRST DOUBLE BOND IN NATURAL FAT FATTY ACIDS

THE studies on glyceride structure of natural fats by gravimetric azelaoglyceride analysis technique<sup>1-3</sup> have revealed that the dibasic acids isolated from the filtrates obtained after separation of Bertram acids from the hydrolysis product of magnesium salt insoluble azelaoglycerides (IAG) in many instances have the mean molecular weight (MMW) considerably higher than that of azelaic acid (188). The deviation is enough to account for the presence of appreciable amount of isomers having first double bond (FDB) in a position other than



$\Delta^9$ <sup>10</sup>, since a difference of 14 units is sufficient to shift a double bond by one carbon atom.

These deviations will introduce errors in the method<sup>3</sup> of calculations for azelaoglyceride composition, where MMW of dibasic acids is assumed to be 188. Hence, to ascertain the validity of the application of method of calculations, during the course of studies on glyceride structure of fats by azelaoglyceride technique, the author has determined MMW of dibasic acids isolated as follows from some seed fats.

The fat from sun-dried seeds of *Buchanania lanzan*, *Citrus decumana*, *Solanum indicum*, *Calophyllum inophyllum* and *Hibiscus cannabinus* was Soxhlet extracted using petroleum ether (40–60°C.) and refined by 1% alkali (containing 5% ethanol) as usual.

The refined fat was subjected to acetic-acid-acetone-permanganate oxidation,<sup>2</sup> the dibasic acids isolated and MMW determined as follows:

About 3–5 gm. refined fat was dissolved in 250 ml. acetone containing 15 ml. acetic acid and about 40 gm. powdered potassium permanganate added in small lots of 3–5 gm. at a time. The reaction mixture was gently refluxed on boiling water-bath for 10–12 hours. After addition of about half the potassium permanganate, about 5 ml. acetic acid was also introduced to keep the reaction mixture acidic throughout the oxidation, which prevents loss of azelaoglycerides by hydrolysis. The refluxing was stopped when oxidation was complete as shown by persistence of permanganate colour for 30 minutes.

The oxidation was followed by distilling off acetone, addition of 100 ml. water, heating on water-bath to break the mass and dissolving the manganese dioxide produced in the reaction, by alternate addition of sulphuric acid and sodium bisulphite till blackish colour disappeared.

The clear oily layer was extracted by sulphuric ether, washed by 5% potassium carbonate and then Mg-salt insoluble azelaoglycerides precipitated by adding sufficient 10% ammonium chloride and 15% magnesium sulphate till no more precipitated. The precipitate was filtered off quantitatively and dilute sulphuric acid used to decompose the precipitate. The oily layer was extracted by sulphuric ether and later distilled off to constant weight.

The insoluble azelaoglycerides so obtained were hydrolyzed by excess alcoholic potash and higher saturated acids separated according to

improved Bertram separation.<sup>5</sup> The combined filtrates were concentrated, acidified, saturated with sodium chloride and extracted with solvent ether, several times. The ether extract was washed free of mineral acid, distilled off to constant weight and neutralization equivalents of acids so recovered determined by titration.

The experimental value for MMW of dibasic acids from all the five seed fats reported in this communication is found to be 188 which is in agreement with the assumed value suggesting thereby that the original method of calculation can be applied to these fats.

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Division of Genetics, J. M. S. MATHUR.  
Indian Agricultural  
Research Institute,  
New Delhi-12, October 15, 1967.

1. Narayanan, R., *Ph.D. Thesis*, Delhi University, 1958.
2. Kartha, A. R. S., *J. Am. Oil Chem. Soc.*, 1953, 30, 280.
3. —, *Ib. id.*, 1953, 30, 326.
4. —, *Ibid.*, 1955, 42, 351.
5. —, *J. Sci. and Ind. Res.*, 1954, 13 A, 72.

## PROTOZOA IN BIHAR SOILS

A STUDY was made to estimate the population of protozoa in Bihar soils of which no published work is available at present. Twenty soils representing different agro-climatic zones in Bihar, comprising 8 alluvial (old and new) and 12 sedentary soils from Kanke (Ranchi)—5 from permanent manurial trials and 7 from plots with different kinds of vegetation were studied for the population of protozoa by culture method of Singh (1955). The bacterial food used for cultivating protozoa was a strain of *Escherichia coli* grown on nutrient agar. A drop each of a thick suspension of this organism was put at 5 places in petridish containing 15 ml. of non-nutrient agar (1.5% agar in 0.5% NaCl solution, pH 7.0), to form 'bacterial' circles serving as 5 replicates. A drop of soil suspension of known volume of required dilution was placed in the centre of each circle. The plates were incubated at 20–22°C. for 1 to 2 weeks and examined under microscope as such or as slides for the presence of amoebae, flagellates and ciliates. For calculation 3 soil dilutions were considered, one of

which showed all positives and at least another which proved to be negative. By making a reference to McCrady's (1918) Table most probable number was calculated and converted to thousands per gram of the soil.

The protozoan population ranged from 157 to 8873 thousands. This number is considerably higher than usually reported in the literature largely for non-tropical soils. The occurrence of protozoa was higher in lowlands (319 to 8873 thousands) than in uplands (273 to 515 thousands) and under manuring (431-834 thousands) than without it (300 thousands). The stimulatory effect of organic manure (549-834 thousands) was of higher order than that of fertilisers (431-527 thousands). Considerable differences in the population of protozoa were observed in the samples collected from Kanke soils with different vegetation. The lowest was recorded in case of dub (*Cynodon dactylon*) lawn (157 thousands) and the highest in berseem (*Trifolium alexandrinum*) plot (3438 thousands). Potato, paddy, peas, gram and flower garden gave figures ranging from 222 to 669 thousands/g.

In freshly collected samples from Kanke, surface soils (0-3" depth) invariably contained higher number of protozoa (3958 to 7273 thousands) than the sub-surface ones (3-6" depth, 596 to 3599 thousands). It diminished further with the depth being as low as 147 to 992 thousands for 6-9" and 9-12" samples. Relatively high density of protozoa in berseem plots, in surface soils as well as those under manuring, where bacterial population are known to be high, is indicative of a close relationship between the two groups of organisms, an observation consistent with the findings of others (Alexander, 1961).

Agricultural Res. Inst.,  
Kanke, Ranchi,  
Bihar (India),  
October 3, 1967.

JHULAN PRASAD.  
K. K. JHA.

### VAVILOVOID MUTANT IN *TRITICUM DURUM* DESF.

In the course of our studies on the frequency and spectrum of mutations induced by different physical and chemical mutagens and by gametic irradiation in three varieties of *Triticum durum* desf., vavilovoid, mutant of phylogenetic importance was isolated.

In the \*EMS (1/300) treatment of variety N.P. 411, one plant progeny segregating for vavilovoid mutants was observed. Three such plants were isolated. The spikes had a branched appearance due to an increase in the length and number of nodes of rachilla (Fig. 1). The other changes observed in plants with elongated rachilla were slender culm, reduced length of awns and non-free threshing habit. Seeds of these three vavilovoid mutants were sown in  $M_3$  generation to study their breeding behaviour. All the three mutants bred true.



FIGS. 1-2. Fig. 1. Ear and spikelet of variety N.P. 411. Fig. 2. Ear and spikelet of vavilovoid mutant.

There are some reports of such mutants in tetraploid wheats. Barabas<sup>1</sup> in his experiments on X-ray irradiated *Triticum carthlicum* (4x), isolated one vavilovoid mutant in  $X_3$  generation. The mutant bred true in the  $X_4$  generation. He stated that the mutation of a single gene to the recessive condition would be the most simple explanation for this mutant which bred true in  $X_4$ . Scarascia *et al.*<sup>2</sup> also obtained a similar mutant in the  $M_2$  generation of variety Cappelli of *Triticum durum*. They

1. Alexander, M., *Introduction to Soil Microbiology*, John Wiley and Sons, New York, 1961, p. 111.
2. McGrady, M. H., *The Public Health J.*, Canada, 1918, 9, 201.
3. Singh, B. N., "Culturing soil protozoa and estimating their numbers in soil," *Soil Zoology*, Ed. Kevan Butterworths Scientific Publication, London, 1955, p. 403.

explained it as a single mutational step and found it as a monogenic recessive condition by studying the segregation in the  $M_3$  generation. Singh *et al.*<sup>2</sup> studied the genetics of *Triticum varilovi* and obtained a 2-gene segregation in crosses between *T. aestivum* and *T. varilovi*. Rao and Swaminathan<sup>1</sup> have shown that the free threshing gene 'Q' suppresses the expression of the vavilovoid character in *T. aestivum*. The vavilovoid mutations isolated by Barabas,<sup>1</sup> Searaschia *et al.*<sup>2</sup> and the present author in free threshing tetraploid wheats have all shown a non-free-threshing habit and reduced awn development. Thus, the genetic change involved may be similar to that occurring in the hexaploid level.

This study was carried out under the guidance of Dr. M. S. Swaminathan.

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\* EMS (Ethyl methane Sulphonate) was obtained from the Eastman Kodak Chemicals, U.S.A. The concentration used here, is one part of EMS in 300 parts of distilled water.

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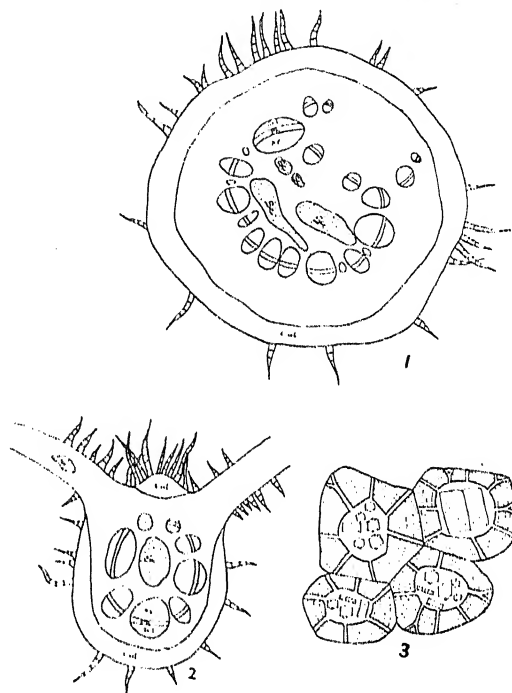
1. Barabas, Z., *Nat.*, 1959, **183**, 1349.
2. Searaschia, G. T., D'Amato, E. and Bozzini, A., *Att. A.G.L.*, 1961, **6**, 371.
3. Singh, H. B., Anderson, E. and Pal, B. P., *Jukni. Agron. J.*, 1957, **49**, 4.
4. Rao, M. V. P. and Swaminathan, M. S., *Curr. Sci.*, 1963, **32**, 132.

### FOLIAR SCLEREIDS IN *CLERODENDRUM FRAGRANS* R.Br.

In angiosperms sclereids are reported to be present in various organs of the plant (Esau<sup>1</sup>). Foliar sclereids are not reported in any member of the family Verbenaceae (Solereder,<sup>5</sup> Metcalfe and Chalk,<sup>3</sup> Rao<sup>4</sup>). Sclereids are reported in the pericarp of the fruit of *Lippia nodiflora* Rich. a member of Verbenaceae (Maheshwari<sup>2</sup>). During the course of morphological and anatomical studies in the species of the genus *Clerodendrum* sclereids were firstly observed in *Clerodendrum fragrans* R.Br. which is a small beautiful shrub cultivated in local gardens for its fragrant flowers. The present note deals with the study of foliar sclereids in *Clerodendrum fragrans* R.Br.

Sclereids are abundant and diffuse. They are distributed in the petiole, mid-rib region and mesophyll tissue of the leaf (Figs. 1 and 2).

In the petiole and the mid-rib region sclereids are observed within the ring of vascular bundles while in the mesophyll they are found scattered in the spongy parenchyma. They occur in large patches forming distinct strands or very rarely solitary. They are spheroidal, crystalliferous containing crystals of Ca-oxalate (Fig. 3). The crystals are of varied forms,



FIGS. 1-3. Fig. 1. T.S. of petiole showing patches of sclereids,  $\times 55$ . Fig. 2. T.S. of leaf showing sclereids in the mid rib region and mesophyll tissue,  $\times 55$ . Fig. 3. Spheroidal crystalliferous sclereids,  $\times 220$ .

they are hexagonal, rod-like and rectangular and are deposited in the lumen of the sclereids. The sclereids have large lumen and strong pits. The pit canals are either simple or rami-form and of straight or oblique disposition. The sclereids have concentric lamellation.

Univ. Dept. of Botany, J. A. INAMDAR.  
Sardar Patel University,  
Vallabh Vidyanagar,  
Gujarat, August 24, 1967.

1. Esau, K., *Anatomy of Seed Plants*, John Wiley & Sons, New York, 1962.
2. Maheshwari, J. K., *Phytomorphology*, 1954, **4** (1-4), 217.
3. Metcalfe, C. R. and Chalk, I., *Anatomy of Dicotyledons*, Oxford, 1950, 2.
4. Rao, T. Anand, *J. Ind. bot. Soc.*, 1951, **30**, 28.
5. Solereder, H., *Systematic Anatomy of Dicotyledons*, Oxford, 1908, 1.

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## REVIEWS AND NOTICES OF BOOKS

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**Many-Body Problems and Other Selected Topics in Theoretical Physics.** Edited by M. Moshinsky, T. A. Brody and G. Jacob. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York, N.Y. 10011), 1967. Pp. 958. Price cloth: \$49.00; paper: \$15.75.

The Latin American School of Physics was initiated in 1959 with the purpose of giving short courses in advanced fields of physics which would help researchers keep up with recent developments.

The School takes place in July-August, each year in a different country in Latin America. So far the school has been restricted to Mexico (1959, 1962, 1965), Brazil (1960, 1963), and Argentina (1961, 1964).

The 1965 session which took place at the University of Mexico is the first to be published in book form by Gordon and Breach Science Publishers, Inc.

The main subject of the 1965 session was Many-Body Problems with Applications to Plasma Physics, Superconductivity and Nuclear Physics. The lectures given in this field are published in this book. The titles and their respective authors are: 1. Basic Many-Body Concepts from a Unified Collective Point of View, by G. Carmi; 2. A Short Introduction to Superconductivity Theory, by R. A. Ferrell; 3. Collective Excitations in Nuclei, by S. T. Belyaev; 4. Group Theory and the Many-Body Problem, by M. Moshinsky; 5. Recent Experimental Tests of Nuclear Models, by B. F. Bayman; 6. The Group  $SU_3$  and Elementary Particles, by A. J. Macfarlane; 7. Symbol-Manipulation Techniques for Physics, by T. A. Brody; 8. The Mossbauer Effect and Its Applications, by J. Danon; and 9. Critical Phenomena, by M. S. Green.

C. V. R.

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**Some Problems of Geodynamics.** By A. E. H. Love. (Dover Publications, Inc., New York), 1967. Pp. xxx + 180. Price \$2.25.

This Dover edition, first published in 1967, is an unabridged and unaltered republication of the work originally published in 1911 by the Cambridge University Press. It is reprinted by permission of the Cambridge University Press.

The scope of this book is indicated by the titles of the chapters contained therein: The Distribution of Land and Water; The Problem of the Isostatic Support of the Continents; The Problem of the Isostatic Support of the Mountains; General Theory of Earth Tides; Effect of Inertia on Earth Tides; Effect of the Spheroidal Figure of the Earth on Earth Tides; General Theory of a Gravitating Compressible Planet; Effect of Compressibility on Earth Tides; The Problem of Gravitational Instability; Vibrations of a Gravitating Compressible Planet; and Theory of the Propagation of Seismic Waves.

C. V. R.

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**The Physics of Modern Electronics.** By W. A. Gunther. Translated from the German by David Antin. (Dover Publications, Inc., New York), 1967. Pp. x + 337. Price \$2.25.

This is a revised, enlarged (1966) edition of *Einführung in die Elektronik*. Translated for Dover by David Antin.

The introduction covers the physical bases of general electronics, answering such questions as how electronics can be influenced and how electronics is related to static electricity and describing conductors, semiconductors, and insulators; Induction Phenomena; and Magnetism. There follow chapters on older types of devices: Intensity-Modulated Tubes, gas diodes, cathode-ray and other high vacuum tubes, and velocity-modulated tubes. Finally, nearly half the text is devoted to an excellent physical exposition of the use of electronics in the latest developments—transistors and molecular amplifiers. The topics covered here are very much in the news: plasma cells, piezoelectric transducers, MHD generator, atomic clocks, microwave spectroscopy, solid state masers, the laser, etc.

C. V. R.

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**Equivalent Circuits of Electric Machinery.** By Gabriel Kron. (Dover Publications, Inc., New York), 1967. Pp. xxix + 278. Price \$2.25.

This Dover edition, first published in 1967, is an unabridged and unaltered republication of the work originally published by John Wiley and Sons, Inc., in 1951, to which has been added a new Preface by the author.

The titles of the chapters contained in this book are: 1. The Physical Model; 2. The

Primitive Machine at Standstill; 3. The Primitive Machine at Constant Speed; 4. The Transformation of Reference Frames; 5. Induction Machines; 6. Synchronous Machines; 7. Commutator Machines; 8. Stationary Networks; 9. Interconnected Machines; 10. Space Harmonics; 11. Time Harmonics; and 12. Sudden Short Circuits and Load Variations. C. V. R.

**Essays in the History of Embryology and Biology.** By Jane M. Oppenheimer. (The M.I.T. Press, Massachusetts Institute of Technology, Cambridge, Mass., U.S.A.), 1967. Pp. 374. Price 100 or \$12.50.

This is a collection of a dozen essays which the author, an experienced investigator and teacher of experimental embryology, had written, spoken or broadcast in response to invitations by societies or organizations concerned with developmental biology. These articles have appeared in some journal or other over a period extending nearly a quarter of a century, and are here reprinted in one volume for the benefit of the experimental scientist, the historian of biology and medicine, and the interested layman. The essays evince deep learning and are written in literary style. The publication is certainly an addition to the literature in the history of science.

Among the articles are the following: Embryological Concepts in the XX Century; Ross Harrison's Contributions to Experimental Embryology; An Embryological Enigma in the *Origin of Species*; The Non-Specificity of the Germ-Layers; John Hunter, Sir Thomas Browne and the Experimental Method, William Harvey and Historical Change; and William Gilbert: Plant Grafting and the Grand Analogy. A. S. G.

**Advances in Electronics and Electron Physics** (Vol. 23). Edited by L. Marton. (Academic Press, Inc., Publishers, 111, Fifth Avenue, New York), 1967. Pp. 490. Price \$22.50.

The titles, authors, and length of articles in its latest issue of *Advances in Electronics and Electron Physics* are as follows: Type II superconductors, by E. A. Lynton and W. L. McLean (1-37); Measurement of Weak Magnetic Fields by Magnetic Resonance, by P. A. Grivet and L. Malnar (39-151); The Radio-Frequency Confinement and Acceleration of Plasmas, by H. Motz and C. J. H. Watson

(153-302); Noise in Semi-conductor Devices, by E. R. Chenette (303-346); Properties and Limitations of Image Intensifiers used in Astronomy, by W. C. Livingston (347-384); and Superconducting Magnet Technology, by C. Laverick (385-474).

These authoritative review articles will aid the research worker to keep abreast of current developments. A. S. G.

**Mining Engineers' Handbook** (In Two Volumes). Edited by Robert Peele and John A. Church. Vol. I: Pp. xiv + 1340; Vol. II: Pp. vii + 1165. (Wiley Eastern Private Ltd., Publishers, J 31, South Extension 1, New Delhi-3). Price Rs. 11 per volume.

Peele's *Mining Engineer's Handbook* is well known as an indispensable reference literature on the title for over half a century. This work is the outcome of the combined efforts of a staff of forty-six specialists under the editorship of the late Professor Robert Peele. The first edition was published in 1917. The second edition was issued in 1927. The third edition came out in 1941 and went through several reprintings, almost once in every two years, to meet the continuing demand. The present edition is the Tenth Printing of the Third Edition. This is also the First Wiley Eastern Edition issued in two volumes at the low cost of Rs. 11 per volume (price of original edition \$22.50 per set) to meet in a fair way the demand for this Handbook in this country and the countries of the East. There is no doubt that this fair-price edition will have a good reception. The book is set in very small types, but probably this could not be avoided under the circumstances of providing extensive and complete information on all aspects of Mining and Mining Engineering in two handy volumes at low price. A. S. G.

**Mathematische Grundlagen Der Genetik.** By Von Erna Weber (Veb Gustav Fischer, Verlag Jena), 1967. Pp. 464. Price 63.80 Geb MDN.

**Problems of Modern Physics.** By H. A. Lorentz. (Dover Publications, New York-14), 1967. Pp. viii + 312. Price \$2.25.

**Direct Correlation of Physical Constants through Transcendental Equations.** By F. Crook. (Published by the Author, Grange Place, Guerresy C. 1, British Isles), 1967. Pp. 16. Price Rs. 20.

# CRYSTALLINE CHEMICAL COMPONENTS OF THE LEAVES OF RHODODENDRON FORMOSUM WALL.

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PLANTS belonging to the genus *Rhododendron* are poisonous to cattle.<sup>1</sup> *R. formosum* is a shrubby plant growing in the Khasia Hills of Assam at altitudes of 3,000 to 5,000 ft. No information is available in the literature regarding its chemistry. The results of our study of the leaves of this plant are described here.

The powdered dry leaves (4 kg.) were extracted with petroleum ether, ether and alcohol in succession. Concentration of the petroleum ether extract led to the deposition of a crystalline solid (12 g., referred to as Fr. 1. in the sequel). The solvent-free residue obtained from the mother liquor consisting of a dark green resinous mass (120 g.) was saponified using 10% sodium hydroxide in benzene-alcohol (1:9); the unsaponifiable matter consisted of a colourless solid (1 g., referred to as Fr. 2).

Fr. 1 was chromatographed over neutral alumina. Petroleum ether eluted a wax which crystallised from chloroform-methanol as colourless needles, m.p. 74–76°. Petroleum ether-benzene (3:1) eluted a substance (A) which crystallised from chloroform-acetone as colourless needles, m.p. 232–33°,  $[\alpha]_D^{25} - 24^\circ$  (chloroform), formula  $C_{30}H_{50}O$ . In the Liebermann-Burchard test it gave a red colour changing readily to pink and finally to green, and in the Salkowski reaction an yellow colour. Tetranitromethane reaction was negative. The compound had I.R. absorptions at 1380 and 1360  $cm^{-1}$  (gem dimethyl group), 1440  $cm^{-1}$  (methylene) and 1710  $cm^{-1}$  (six-membered ring ketone). It formed an oxime, colourless needles from alcohol, m.p. 271–73°, formula  $C_{30}H_{51}NO$ , and a 2:4 dinitrophenylhydrazone, orange-red shining needles from chloroform-alcohol, m.p. 304–06° (d.), formula  $C_{36}H_{54}N_4O_4$ , and it gave a positive Zimmermann colour reaction. These properties showed that it could be a 3-ketotriterpenoid. Reduction of the ketone with  $NaBH_4$  in methanol-dioxan (3:1) yielded an alcohol (dihydro-A), shining plates from acetone-chloroform, m.p. 269–71°,  $[\alpha]_D^{25} + 21^\circ$  (chloroform), formula  $C_{30}H_{52}O$ . This gave an acetate (pyridine-acetic anhydride at 38°), colourless plates from chloroform-methanol, m.p. 290–93°, formula  $C_{32}H_{54}O_2$ . Under the Clemmensen or

Wolff-Kishner reduction conditions the ketone (A) yielded a hydrocarbon shining plates from chloroform-petroleum ether, m.p. 226–28°,  $[\alpha]_D^{25} \pm 0^\circ$  (chloroform), formula  $C_{30}H_{52}$ . The properties of these three substances are set out in Table I along with those of dihydrotaraxerone,

TABLE I

Name of Compound	Formula	m.p. (°)	$[\alpha]_D^{25}$ (°)
Compound A	$C_{30}H_{50}O$	232–3	–24
Dihydrotaraxerone	$C_{30}H_{50}O$	229–31	+30.8
Dihydro-A	$C_{30}H_{52}O$	269–71	+21
Dihydrotaraxerol	$C_{30}H_{52}O$	261–62	+24.3
Hydrocarbon	$C_{30}H_{52}$	226–8	$\pm 0$
Taraxerane	$C_{30}H_{52}$	224–6	+15

dihydrotaraxerol and taraxerane which were prepared by Takeda<sup>2</sup> in the course of a study of taraxerol. By and large the two series of substances seem to be identical notwithstanding the disagreement between the rotations of compound A and dihydrotaraxerone. The reason for this disparity is not clear. Further, the N.M.R. spectrum of the acetate of dihydro-A was in agreement with its structure as dihydrotaraxerol acetate. Special mention may be made of the fact that there was no signal in the region 4.9 to 5.5  $\delta$  showing the absence of vinylic protons.<sup>3</sup> This together with the observation that the I.R. spectrum of compound A showed no ethylenic absorption in the region 1600  $cm^{-1}$  is clear evidence that compound A is a fully saturated molecule, and the available evidence seems to indicate that substance A may be dihydrotaraxerone. This substance has not so far been found to occur in nature.

In the chromatogram of Fr. 1 already mentioned, benzene-chloroform (3:1) eluted a third compound (compound B) which crystallised from chloroform-acetone as colourless needles, m.p. 166–68°,  $[\alpha]_D^{25} + 54^\circ$  (chloroform); formula  $C_{30}H_{50}O$ . It gave a bright red colour in Liebermann-Burchard reaction, which immediately turned to violet. The tetranitromethane test was positive. It did not form an acetate nor did it give a positive test with DNP reagent. The I.R. spectrum showed absorptions at 1380 and 1365  $cm^{-1}$  (gem dimethyl) and 1450  $cm^{-1}$  (methylene) confirming its triterpenoid nature while the



absorption at  $1096\text{ cm}^{-1}$  indicated the probable presence of an ether oxygen as part of a five-membered ring.<sup>4</sup> Dearth of material prevented more detailed work.

Fr. 2 mentioned earlier was chromatographed over neutral alumina. The petroleum ether-benzene (9:1) eluate yielded compound B mentioned in the above paragraph. Petroleum ether-benzene (1:1) eluted another substance which crystallised from chloroform-acetone as colourless needles, m.p.  $185-86^\circ$ ,  $[\alpha]_D + 67^\circ$  (chloroform), formula  $\text{C}_{30}\text{H}_{52}\text{O}$ ; Liebermann-Burchard reaction was positive and tetranitromethane reaction negative. I.R. absorptions at  $1380$  and  $1360\text{ cm}^{-1}$  (gem dimethyl) and  $1460\text{ cm}^{-1}$  (methylene) were in agreement with a triterpenoid type of structure, while the absorption at  $3520\text{ cm}^{-1}$  showed the presence of a hydroxyl. It formed an acetate  $\text{C}_{32}\text{H}_{54}\text{O}_2$ ; colourless needles from alcohol, m.p.  $189-90^\circ$ ,  $[\alpha]_D + 85^\circ$  (chloroform); benzoate,  $\text{C}_{37}\text{H}_{56}\text{O}_2$ , colourless needles from chloroform-methanol, m.p.  $191-93^\circ$ ,  $[\alpha]_D + 89^\circ$  (chloroform). Oxidation with either chromic acid in glacial acetic acid or dichromate in acetone-sulphuric acid gave a low melting ketone which gave a 2:4-dinitro-phenylhydrazone of m.p.  $178-81^\circ$ , had I.R. absorption at  $1710\text{ cm}^{-1}$  (6-membered ring ketone) and showed a positive Zimmermann reaction ( $-\text{CO}-\text{CH}_2-$ ). These led to the probable location of the alcoholic group in the parent compound at position 3. Further work could not be continued for want of material.

Concentration of the ether extract of the leaves led to the deposition of an amorphous solid. This was dissolved in excess of methanol-benzene (1:1), diluted with water and the resulting suspension extracted with ether. The organic solvent phase was shaken with 5% aqueous sodium hydroxide when a considerable amount of precipitate separated at the interphase. The aqueous alkali phase and organic phase did not yield any useful residue. The precipitate at the interphase was dissolved in excess of methanol and boiled with mineral acid. The resulting substance yielded an acetate, long needles from alcohol, m.p.  $288-91^\circ$ ,  $[\alpha]_D + 62^\circ$  (chloroform), formula  $\text{C}_{32}\text{H}_{50}\text{O}_4$ . It was identified as ursolic acid acetate by mixed m.p. and comparative T.L.C. employing authentic sample. Examination of the parent acid by T.L.C. showed that it was mostly ursolic acid (comparison with authentic sample).

The concentrated alcoholic extract of the leaf deposited an almost colourless solid which was

crystallised from hot water and identified as potassium hydrogen tartrate. From the alcoholic filtrate the solvent was completely removed, the residue extracted with ethyl acetate, the extract dried, concentrated and diluted with petroleum ether. The precipitated amorphous solid (2g.) gave colour reactions both for proanthocyanidins (intense pink colour on boiling with alcoholic hydrochloric acid) and dihydroflavonols (blue colour with  $\text{Zn-HCl}$  even at low temperature). On extracting the mixture with moist ether the dihydroflavonol went into the solvent and proanthocyanidin was left behind. The dihydroflavonol fraction though free from proanthocyanidin was slightly impure. It was boiled with 2N aqueous sulphuric acid at  $100^\circ$  for 30 hours (aerial oxidation). The flavonol that resulted crystallised from aqueous alcohol as yellow needles, m.p.  $308-12^\circ$  (d.); formula  $\text{C}_{15}\text{H}_{10}\text{O}_7$ . It gave an acetate, colourless needles from alcohol, m.p.  $194-96^\circ$ , formula  $\text{C}_{25}\text{H}_{20}\text{O}_{12}$ . The acetate showed no depression in mixed m.p. with authentic quercetin penta-acetate and the flavonol gave all the colour reactions of quercetin and had spectral properties in the U.V. and visible region including shifts with various reagents as described in the literature for this substance. The parent dihydroflavonol should therefore be taxifolin and this was confirmed by comparing it with authentic taxifolin employing descending paper chromatography and butanol-acetic acid-water (4:1:5) (upper phase) as the irrigating solvent.

The proanthocyanidin mentioned earlier was found to be a single entity by paper chromatography using 50% acetic acid ( $R_f$  0.5) and butanol-acetic acid-water (4:1:5) (upper phase) ( $R_f$  0.84). It was refluxed with 1N alcoholic  $\text{HCl}$  for 2 hrs. After cooling it was extracted with ethyl acetate, the ethyl acetate extract washed with aqueous sodium bicarbonate and the solvent removed. Examination of the residue by descending paper chromatography<sup>5</sup> showed the presence of *epi*-catechin (comparison with authentic sample). The flavylum salt remaining in the aqueous acid phase was purified in the usual manner and finally obtained in the form of a solution in 0.1 N aqueous  $\text{HCl}$ . It showed all the colour reactions of cyanidin chloride and it had absorption in the visible region at  $540\text{ m}\mu$  which shifted to  $558\text{ m}\mu$  on the addition of  $\text{AlCl}_3$ . Its identity as cyanidin chloride was confirmed by comparative paper chromatography using authentic material. Hence the parent proanthocyanidin



seems to be built up of leucocyanidin and epicatechin. Further details could not be studied due to lack of material.

To sum up the results, the leaves of *Rhododendron formosum* contain the following known compounds: dihydrotaraxerone, ursolic acid and taxifolin. It also contains two possibly new triterpenoids, and a proanthocyanidin built up of leucocyanidin and epicatechin. Dihydrotaraxerone is a substance having a saturated ring system and has not been known so far to occur in any natural source; very few compounds of this type are known to occur in nature so far.

The authors are grateful to Professor T. R. Seshadri, F.R.S., for his kind interest.

1. Chopra, R. N., Badhwar, R. L. and Ghosh, S., *Poisonous Plants of India*, Indian Council of Agricultural Research, New Delhi, 1965, 1, 513.
2. Takeda, K., *J. Pharm. Soc.*, Japan, 1943, 63, 193; *C.A.*, 1951, p. 586.
3. Shamma, M., Glick, R. E. and Mamma R. O., *J. Org. Chem.*, 1962, 27, 4512.
4. Borrow, G. M. and Searles, S., *J. Am. Chem. Soc.*, 1953, 75, 1175.
5. Freudenberg, K. and Weinges, K., *The Chemistry of Flavonoid Compounds*, Ed. T. A. Geissman, Pergamon Press, 1962, p. 201.

## THE ASYMPTOTIC THEORY OF THE BLUNTED WEDGE AT HYPERSONIC SPEEDS

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AS a logical extension of the asymptotic theory for the blunted flat plate and the circular cylinder at hypersonic speeds, which has been treated in great detail by Guiraud *et al.*, Roberto Vaglio Laurin, Freeman and others, an attempt is made to treat the direct problem of the blunted slender wedge at  $M_\infty = \infty$ , by the method of matched asymptotic expansions. It is assumed that the asymptotic shock wave shape corresponds to the sharp wedge solution and a first correction to the shock shape has been obtained in the presence of blunting.

It is found that the matching could be effected only if the displacement thickness of the entropy layer is zero. A global energy and mass flow criteria have been employed to verify that the first correction is the only one compatible with the assumed shock shape and the given body and that this correction is found to be due to the body and not the entropy layer. There are two regions present in the flow, viz., an 'outer region' where small perturbation solutions are valid and an 'inner boundary-layer-like region' called the entropy layer (hot, low-density gas that crosses the strong portion of the bow shock near the nose) where different approximations are required. The entropy layer plays an important role in the description of flows over hypersonic speeds and renders the associated asymptotic patterns non-similar by its presence. An asymptotic behaviour of the shock wave is written *a priori* with undetermined parameters which are determined finally, so that the body corres-

ponding to the shock is the one we wished to obtain asymptotically.

An analytical scheme has been developed to obtain a uniformly valid solution of the complete flow field. The equations for the steady flow of an inviscid, perfect gas with constant specific heats in Von Mises co-ordinates  $(x, \psi)$  are

$$\frac{\partial y}{\partial x} = \frac{v}{u} \quad (1.1.1)$$

$$\frac{\partial y}{\partial \psi} = \left( \frac{1}{\rho u} \right) \quad (1.1.2)$$

$$\frac{\partial v}{\partial x} + \frac{\partial p}{\partial \psi} = 0 \quad (1.1.3)$$

$$u^2 + v^2 = \frac{2\gamma}{(\gamma - 1)\rho} p = 1 \quad (1.1.4)$$

$$\frac{p}{\rho^\gamma} = G(\psi) = \left( \frac{2}{\gamma + 1} \right) \left( \frac{\gamma}{\gamma + 1} \right)^\gamma \sin^2 \beta(\psi) \quad (1.1.5)$$

where  $\beta$  is the shock wave angle. All the flow variables have been non-dimensionalised with respect to the freestream quantities, velocities being referred to  $U_\infty$ , density to  $\rho_\infty$ , and pressure with respect to  $\rho_\infty V_\infty^2$ . The distance variables have been non-dimensionalised with respect to the bluntness parameter 'd'. The shock wave slope is assumed to be the unknown and expressed in the form

$$h(x) = (\sin \beta)^{2/\gamma} \quad (1.1.6)$$

and  $h(x)$  is developed asymptotically along the lines given by Guiraud<sup>2</sup> as

$$h(x) \approx \frac{h_0}{x^{\alpha_0}} \left\{ 1 + \frac{h_1}{x^{\alpha_1}} + \dots \right\} \quad (1.1.7)$$

The leading exponent  $\alpha_0$  of this expansion is taken to be zero based on the fact that the

solution should tend to the sharp wedge solution asymptotically for downstream.  
Boundary condition.—

$$\frac{v}{u} = \tan \alpha \quad (1.1.8)$$

on the body where  $\alpha$  is the semiwedge angle. The outer variables are chosen as  $(x, \omega)$  where  $\omega = y/\chi$  and functions are denoted by an asterisk.  $\omega = 0(1)$  near the shock wave. The inner variables are taken as  $(x, \psi)$  where  $\psi = 0(1)$  near the wedge and functions are denoted by  $\sim$ . The flow variables are expanded asymptotically as follows:

$$f^*(x, \omega) \sim f_0^*(\omega) + \frac{h_1 \tilde{f}_1^*(\omega)}{x^{\alpha_1}} + \dots \quad (1.2.1)$$

$$Y^*(x, \omega) \sim x Y_0^*(\omega) + \frac{h_1 Y_1^*(\omega)}{x^{(\alpha_1-1)}} + \dots \quad (1.2.2)$$

The general equations of motion written in outer variables  $(x, \omega)$  are as given below.

$$\frac{\partial Y}{\partial x} = \frac{v}{U} = \frac{\omega}{DU} \quad (1.3.1)$$

$$\frac{\partial Y}{\partial \omega} = \frac{x}{DU} \quad (1.3.2)$$

$$x \frac{\partial v}{\partial x} + \omega \frac{\partial v}{\partial \omega} + \frac{\partial P}{\partial \omega} = 0 \quad (1.3.3)$$

$$U^2 + V^2 = \frac{\gamma P}{(\gamma - 1) D} = 0 \quad (1.3.4)$$

$$\frac{P}{D^\gamma} = \left( \frac{\gamma}{\gamma - 1} \right) (\gamma - 1)^\gamma$$

$$= \left[ h_0 \gamma \left( 1 + \frac{h_1}{x^{\alpha_1}} + \dots \right)^\gamma \right] \quad (1.3.5)$$

substituting the expansions for the flow and distance variables in the equations of motion and collecting coefficients of powers of  $x$ , we respectively get zeroth outer, first outer, etc., system of equations. The zeroth outer system corresponds to the sharp wedge solution as given by Yakura and they can be solved with the help of the boundary conditions. It must be remarked here that although the flow variables are uniformly valid for all ' $\omega$ ', this is not true for the distance variable,  $Y$ , because the body condition is not satisfied. Hence an inner expansion has to be constructed, taking the entropy layer and the body condition into consideration. From a study of the outer equations near  $\omega = 0$ , it can be inferred that the leading terms of the inner expansions for the flow variables must be of the following form

$$\tilde{f}(x, \psi) \sim \tilde{f}_0(\psi) + \frac{\tilde{f}_1(\psi)}{x^{\beta_1}} + \dots \quad (1.4.1)$$

$$\tilde{y}(x, \psi) \sim A x + \tilde{y}_0(\psi) + \frac{\tilde{y}_1(\psi)}{x^{\beta_1-1}} + \dots \quad (1.4.2)$$

The differential equation for  $Y_1^*(\omega)$  is of second order with a non-homogeneous term of order  $(\omega - \alpha_1^{-1})$  on the right-hand side. In order to construct the inner expansion for the flow variables, it is imperative to know the behaviour of the outer functions near  $\omega = 0$ . Since the perturbation in the shock shape is dependent upon the streamline displacement, the behaviour of the distance variable  $Y$  is studied near  $\omega = 0$ . The second order differential equation for  $Y_1^*(\omega)$  is as follows:

$$\frac{d^2 Y_1^*}{d\omega^2} (A\omega^2 + B\omega + C) + \frac{dY_1^*}{d\omega} (D\omega + E) + FY_1^* = G\omega^{\alpha_1-1} + H \quad (1.4.3)$$

where  $A, B, \dots, H$  are functions of  $P_0^*, D_0^*, \dots$  etc. The general solution for  $Y_1^*$  can be written in the form

$$Y_1^*(\omega) \sim (P + Q \log \omega) \omega^{(\alpha_1-1)} \quad (1.4.4)$$

near  $\omega = 0$ . The constants of integration can be obtained by matching.

The choice of the index in the first correction is decided from a consideration of the global mass flow conservation and energy balance. It is found that  $\alpha_1 = 1$  leads to a logarithmic term for the drag which necessitates a 'log term' in the shock wave shape and matching becomes difficult.  $\alpha_1 = 2$  is found to be the right index. It must be remarked here that this first correction to the shock shape is due to the body development and that the entropy layer effects are of a higher order. As it is not possible to guess the complete outer expansions *a priori* the procedure adopted is to start from the zeroth outer system of equations, then go to the zeroth inner and afterwards first outer and so on to effect matching.

#### ACKNOWLEDGEMENTS

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1. Freeman, N. C., "Asymptotic solutions in hypersonic flow: An approach to second order solutions of hypersonic small disturbance theory," *N.P.L. Aero Report*, 1962, 1075, Hyp. 265.
2. Guiraud, J. P., Valler D. & Zalver *Basic Developments in Fluid Dynamics*, Ed M. Holt, 1965, 1, 127.
3. Messiter, A. F., "Asymptotic theory of inviscid hypersonic flow at large distance from a blunt-nosed body," *Report of "BAMIRAC, 4613-S1-T"*, 1965.
4. Vaglio Laurin, R., "Asymptotic flow pattern of a hypersonic body," *P/BAL Report No. 805*, 1964.
5. Yakura, J. K., "A theory of entropy layers and nose bluntness in hypersonic flow," *SUDAER No. 110*, 1961.

## MULTIPLICATION OF ARBOVIRUSES IN CELL LINES FROM *Aedes albopictus* AND *Aedes aegypti*

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A LIMITED degree of multiplication of mosquito and tick-borne viruses has been previously shown in primary mosquito and tick cell cultures or tissues maintained *in vitro*.<sup>1-6</sup> Suitor<sup>7</sup> reported the multiplication of Japanese encephalitis virus in Grace's continuous cell lines of *Antheraea eucalypti*, a moth, which however, is not a vector of arboviruses. But the recent development of mosquito cell lines<sup>8</sup> in this laboratory has made it possible to study the growth and behaviour of arboviruses extensively.

This communication reports the results of a successful study on the multiplication of some of the arboviruses in Singh's recently established<sup>8</sup> cell lines of *A. albopictus* and *A. aegypti*.

*A. albopictus* and *A. aegypti* cell lines from 22nd passage to 29th passage were used in this study. Cells were grown as stationary tube cultures for testing the multiplication of the arboviruses. Stock cultures of both the cell lines were maintained in bottles. The cells were harvested as described by Singh,<sup>8</sup> 1:10 and 1:3 dilutions of cell suspensions of *A. albopictus* and *A. aegypti* respectively were prepared and 0.5 ml. of the suspensions dispensed per tube. At 30° C. cells of *A. albopictus* grew into a complete monolayer in three days and those of *A. aegypti* in five days.

The following virus strains were used: Chikungunya (VRC No. 634029) and Sindbis (AR 339) of arbovirus group A; Kyasanur Forest disease (VRC No. 616104-10), Japanese encephalitis (VRC No. P 20778), West Nile (E 101), dengue 1 (VRC No. 623996), dengue 2 (VRC No. 64421), dengue 3 (VRC No. 633798) and dengue 4 (VRC No. 624000) of arbovirus group B. All these virus strains have undergone many passages intracerebrally (i.c.) in infant or adult albino mice and are well adapted to these animals.

Virus titrations were made in VERO cells which were originally received from Yale Arbovirus Research Unit, New Haven, Connecticut, USA. Monolayer cultures of VERO cells were grown as stationary tube cultures in

minimal essential medium (MEM) with 10% foetal bovine serum. Fully grown monolayers maintained in MEM with 2% foetal bovine serum were used for viral assay.

Titrations of dengue viruses were carried out by inoculations of tenfold dilutions of the virus i.c. in 2-day-old infant mice, the inoculum being 0.02 ml. per mouse.

Fifty cultures of each cell line were inoculated with 0.1 ml. volume of virus diluted in MEM, so as to give 2.0 to 3.0 log LD<sub>50</sub> or TCID<sub>50</sub> of each virus per culture.

The inoculum was titrated at the same time to find out the exact dose of virus. Titrations were carried out either in VERO cells or i.c. in infant mice. All inoculated mosquito and VERO cell cultures were washed twice, after two hours of incubation, with Rinaldini's Salt Solution and MEM/M 199 respectively and the fresh medium was added. Mosquito cell cultures were incubated at 30° C. and VERO cultures at 37° C.

Every day from 1st to 6th day and then on 8th, 10th and 15th days after inoculation, two tubes inoculated with each virus, other than dengue viruses from each cell line were stored at -50° C. at least for 24 hours. In case of dengue viruses the tubes were stored on 1st, 3rd, 5th, 7th, 10th, 15th and 20th post-inoculation days. The tissue culture fluids from the two tubes of each day were rapidly thawed, pooled, centrifuged and titrated either in VERO cell cultures or i.c. in infant mice to assay the infective virus content in the tissue culture fluids on the day of storage. The infective virus titres were calculated as 50% tissue culture infective dose (TCID<sub>50</sub>)/0.1 ml. for VERO cultures or 50% lethal dose (LD<sub>50</sub>)/0.02 ml. for mice, according to the method of Reed and Muench.<sup>9</sup>

The growth-patterns of the viruses which multiplied in *A. albopictus* and *A. aegypti* cell lines are represented in Figs. 1, 2 and 3.

Chikungunya, Sindbis, Japanese encephalitis and West Nile, all mosquito-borne viruses, grew well in *A. albopictus* cell cultures (Fig. 1). Approximately 10,000 to 100,000-fold increase from the original inoculum was observed with these viruses. Dengue 1, dengue 2, dengue 3 and dengue 4 viruses, which are also transmitted by mosquitoes, showed multiplication in *A. albopictus* cell cultures but the

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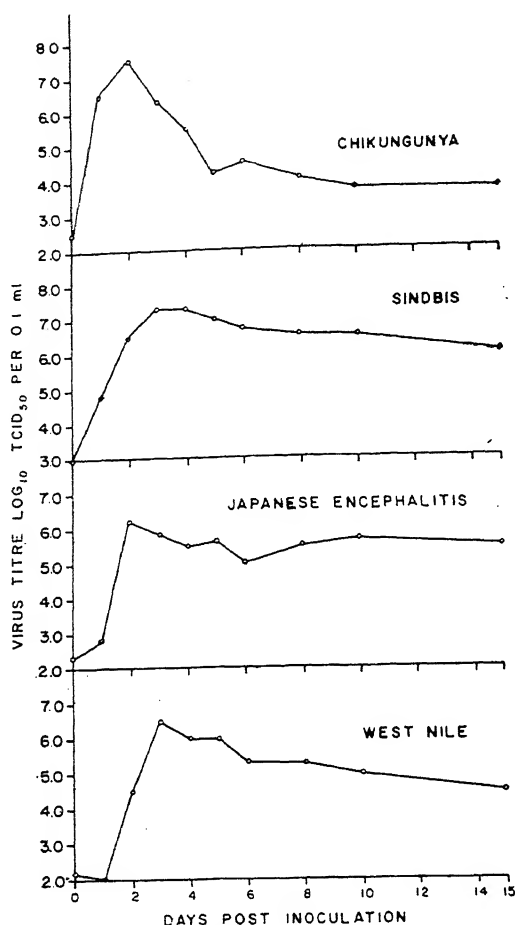


FIG. 1. Multiplication of chikungunya, Sindbis, Japanese encephalitis and West Nile viruses in *A. albopictus* cell cultures;

maximum titres reached did not exceed 2.0 to 3.0  $\log_{10}$  LD<sub>50</sub> (Fig. 2).

The *A. ægypti* cell line could support the multiplication of chikungunya and West Nile viruses only (Fig. 3). The multiplication of chikungunya virus was rapid and the maximum virus titre of  $10^{4.0}$  TCID<sub>50</sub> was reached by the 8th day. The growth of West Nile virus was slow and the maximum virus titre of  $10^{5.0}$  TCID<sub>50</sub> was observed on the 15th PI day. Results on the multiplication of Sindbis virus in this cell line were erratic. Virus growth was detected only on 6th and 15th PI day, when the virus titre observed was  $10^{4.3}$  and  $10^{4.5}$  TCID<sub>50</sub> respectively.

Neither of the cell lines supported the growth of Kyasanur Forest disease virus which is mainly transmitted by ticks.

Cytopathic effect was observed with Japanese encephalitis, West Nile, dengue 1, dengue 2, and dengue 4 viruses in *A. albopictus*

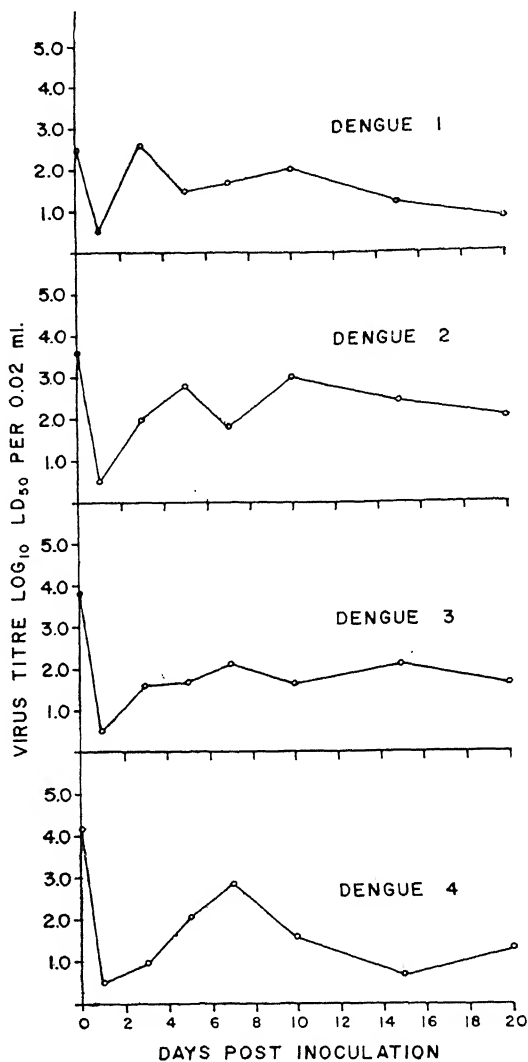


FIG. 2. Multiplication of dengue viruses in *A. albopictus* cell cultures.

cell cultures only. The cultures inoculated with these viruses showed an increase in the granularity of the cells and a proportion of the cells came off the glass wall, as evidenced by the gradual denudation of the glass surface and a number of floating cells in the supernatant medium. At later stages, the cells were seen to clump together in large cellular masses (Figs. 4 and 5).

It is evident from the results of this study that the cell line derived from the larvae of *A. albopictus* is more suitable for the multiplication of arboviruses than that from *A. ægypti*. Differences in the cell types of two cell lines, as described earlier by Singh,<sup>8</sup> might have something to do with the differences in the viral susceptibility of the two cell lines.

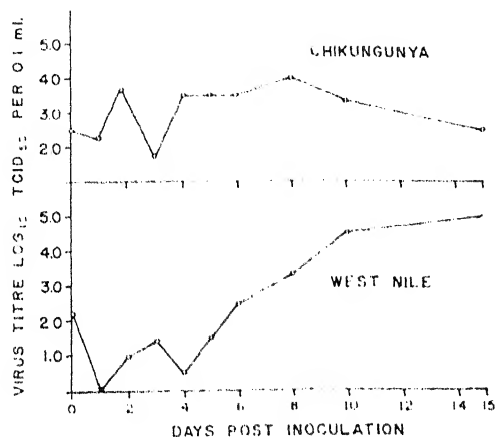
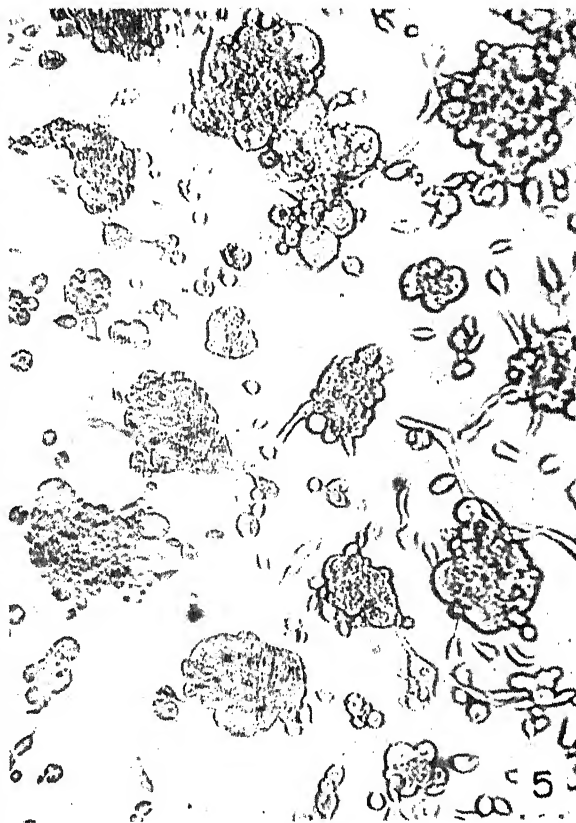


FIG. 3. Multiplication of chikungunya and West Nile viruses in *A. aegypti* cell cultures.



FIGS. 4-5. Fig. 4. Normal cell culture of *A. albopictus*,  $\times 100$ . Fig. 5. Cell culture of *A. albopictus* showing cytopathic effect, 10 days after the inoculation of the West Nile virus,  $\times 100$ .

All of the mosquito-borne viruses tested, multiplied at least in one of the two cell lines whereas neither of the cell lines supported the growth of the tick-borne virus. However, Rehacek<sup>6</sup> has shown that the primary tick tissue culture can support the growth of some

mosquito-borne viruses in addition to the tick-borne viruses.

Cytopathic effect reported here in insect cell culture with arboviruses has been observed for the first time. The detailed study on the nature of the cytopathic effect produced by these viruses in insect cell culture will be reported separately. Susceptibility of these cell lines for some of the other arboviruses isolated from India and for a few representative viruses from other groups is now being tested.

We wish to thank Dr. T. Ramachandra Rao for his advice and keen interest during the course of the present study.

1. Trager, W., *Am. J. Trop. Med.*, 1938, **18**, 387.
2. Rehacek, J. and Pesek, J., *Acta Virol.*, 1960, **4**, 241.
3. —, *Am. Epiphyties*, 1963, **14**, 199.

4. Peleg, J. and Trager, W., *Am. J. Trop. Med. Hyg.*, 1963, **12**, 820.
5. Rehacek, J. and Kozach, O., *Acta Virol.*, 1964, **8**, 470.
6. —, *Id.*, 1965, **9**, 332.
7. Saito, Jr., E. C., *Virology*, 1966, **30**, 143.
8. Singh, K. R. P., *Curr. Sci.*, 1967, **36**, 506.
9. Reed, L. J. and Muench, H., *Am. J. Hyg.*, 1938, **27**, 493.

## NORITE AND CHARNOCKITE

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NORITE and Charnockite in Manbhūm are regarded by Sen<sup>1</sup> as non-consanguineous. Turner and Verohogen<sup>2</sup> while describing the characters of the Adirondack anorthosites regard that charnockites should not be included in the differentiation of the magma which gave rise to norite, anorthosite, granite, diorite and syenite of the area. Probably they restrict the term charnockite to the original description given by Holland, namely, that it is a Hypersthene-granite, and the term norite to a plagioclase-hypersthene rock described by Fay. Holland<sup>3</sup> himself gave the term norite to a two-pyroxene plagioclase granulite which formed a basic member of his charnockite series which extended from the acid to the ultrabasic. Subramaniam<sup>4</sup> describes the hypersthene-bearing rocks of Sittampundi as eclogite-gabbro series, without using the term charnockite series. But Holland has described identical rocks in Pallavaram, the type area in Madras, as members of the charnockite series, though he also, while describing them, uses such classical terminology as norites, pyroxenites, etc. Subramaniam<sup>5</sup> again describes the pyroxene-granulites of Kadavur as noritic anorthosite, gabbroic anorthosite, metagabbro, etc., without specifically mentioning that they are members of the charnockite series, though this noritic gabbro is also a two-pyroxene granulite like any other similar granulite described by scores of petrographers from the hypersthene-bearing rocks of the Madras State. There, thus seems to be a tendency to use the term norite-eclogite, noritic-gabbro, etc., when one wishes to relate these hypersthene-bearing rocks to anorthosites by way of consanguinity. This leads to the inference that there are two series of rock types in the Madras State, (1) the igneous series-norite, norite-gabbro, eclogite, etc., and (2) the charnockite series whose members are also described as norites, pyroxenites, etc., which are regarded by some as metamorphic in origin. These hypersthene-bearing rocks occur in several geological settings, (1) the granulitic members among them occur in a granulite setting along with sillimanite-quartzite, calc-silicate rocks and quartz-magnetite rocks bearing hypersthene or hedenbergite, cummingtonite and grunerite in most of the char-

nockitic areas and occasionally with hornfelses, bearing cordierite, pleonaste, etc., of the Madras State including the type area, (2) these granulites are also associated with, (a) peridotites, dunites, eclogites and magnetite iron ores in Salem, (b) anorthosites in Sittampundi, Kadavur and Palni, (c) granites and enderbites, etc., in the type area, (d) syenites, etc., in Nagarcoil, and (e) nepheline syenites in Kangayam.

It is amazing that a "charnockite" magma could differentiate into these variegated types, dunites, peridotites, eclogites and iron ores in Salem, anorthosites of the Adirondack type in Kadavur and the Bushveld type in Sittampundi, into the charnockite series, acid to ultrabasic (Holland) and into alaskite, birkremite, enderbite, granite and syenite (Subramaniam<sup>6</sup>) in the type area, syenites in Nagarcoil and nepheline syenites in Kangayam.

I am of the opinion that without linking these rocks to any mode of origin, it is more convenient to describe them in the Zirkel-Rosenbusch fashion, i.e., on mineralogy and texture so that their origin would still be open to debate. I accordingly propose the descriptive terms as granulites, gneisses, granites, etc. The term hypersthene may be prefixed to these rock types if one wishes to emphasise the presence of hypersthene in them so that they read as hypersthene-granulites, hypersthene-gneisses, hypersthene-granites, etc. True norites however, i.e., having only orthopyroxene and plagioclase have not been reported from any one of the charnockitic areas of the Madras State, but their dyke equivalents with porphyritic crystals of hypersthene and tachylitic ground mass have been reported from the southern and the northern borders of the Nilgiri range of hills (Naidu,<sup>7</sup> Govinda Rajulu<sup>8</sup>).

1. Sen, S., *J. Geol. Soc. Ind.*, 1967, **8**, 8.
2. Turner, F. J. and Verohogen, J., *Igneous and Metamorphic Petrology*, 2nd Edn., McGraw-Hill, 1960.
3. Holland, T. H., *Mem. Geol. Surv. Ind.*, 1900, p. 28.
4. Subramaniam, A. P., *Bull. Geol. Soc. America*, 1956, **67**, 317.
5. —, *Geol. Mag.*, 1956, **93**, 287.
6. —, *Amer. Jour. Sci.*, 1959, **257**, 321.
7. Naidu, P. R. J., *Pres. Address, Ind. Sci. Cong.*, 1963.
8. Govinda Rajulu, B. V., *J. Univ. Mys.*, 1966, **20**, 35.

## LETTERS TO THE EDITOR

THE CENTRIFUGAL DISTORTION  
CONSTANTS IN  $\text{Si}^{28}\text{F}_3\text{H}$  AND  $\text{Si}^{28}\text{F}_3\text{D}$   
MOLECULES

THE centrifugal distortion constant  $D_J$  was determined for  $\text{Si}^{28}\text{F}_3\text{H}$  experimentally by Heath *et al.*<sup>1</sup> to be approximately 5 Kc./sec. from the measurements in the microwave region on pure rotational transitions  $J = 2 \rightarrow 3$  and  $4 \rightarrow 5$ . For  $\text{Si}^{28}\text{F}_3\text{D}$ , this value was approximately 4 Kc./sec. as determined from the transitions  $J = 1 \rightarrow 2$ ,  $2 \rightarrow 3$  and  $3 \rightarrow 4$ . The pure rotational spectrum of  $\text{Si}^{28}\text{F}_3\text{H}$  molecule in the 1 to 4 mm. wave region was also investigated by Burrus and Gordy<sup>2</sup> specifically to evaluate the two centrifugal stretching constants  $D_J$  and  $D_{JK}$ . More accurate values could be obtained by them from an analysis of the two rotational transitions  $J = 9 \rightarrow 10$  and  $12 \rightarrow 13$  in the 1 to 2 mm. region. The values reported by Burrus and Gordy<sup>2</sup> are shown in Table I. But no such data are reported for the isotopic molecule  $\text{Si}^{28}\text{F}_3\text{D}$ .

The present work has been taken up with a view to evaluate theoretically the three centrifugal distortion constants,  $D_J$ ,  $D_{JK}$  and  $D_K$  for both the molecules using the method due to Kivelson,<sup>3</sup> Wilson<sup>4</sup> and Dowling *et al.*<sup>5</sup> The structural parameters and the force constants required for the calculation are taken from reference 5. The results obtained are given in Table I.

TABLE I

Centrifugal distortion constants in Kc./sec.	$\text{Si}^{28}\text{F}_3\text{H}$		$\text{Si}^{28}\text{F}_3\text{D}$	
	Calculated (a)	Experimental observations (Ref. 2)	Calculated (a)	Calculated (b)
$D_J$	8.57	7.55	8.58	7.46
$D_{JK}$	-13.77	-12.4	-13.77	-11.59
$D_K$	6.2	..	6.2	5.12

It is noticed that (1) the sign of  $D_{JK}$  is consistent with the observations in similar molecules of  $\text{ZX}_3\text{Y}$  type,<sup>6</sup> (2) the calculated values of  $D_J$  and  $D_{JK}$  differ with the experimental values reported for  $\text{Si}^{28}\text{F}_3\text{H}$  by Burrus and Gordy<sup>2</sup> approximately by only 1 Kc./sec., (3) no differences have been noticed in the corresponding values of the three distortion

constants for both the molecules. But it is observed generally from experimental observations in the molecules of  $\text{ZX}_3\text{Y}$  type, that upon substitution for the Y atom, the distortion constants will be reduced as the mass of the substituted atom increases (Table II of Ref. 6). In view of this fact, the distortion constants have been re-evaluated assuming the set of force constants to be the same for both the molecules and these results are also included in Table I.

A comparison of the distortion constants obtained, (a) when the force constants given in reference 5 are used with, (b) those obtained using the same set of force constants as given for  $\text{Si}^{28}\text{F}_3\text{H}$ , leads to the following:

A considerable reduction in the distortion constants for the deuterated species is obtained. Hence the set of force constants which are taken as identical for both the molecules appear to be more acceptable. This conclusion however needs further experimental verification.

The authors are deeply indebted to Prof. K. R. Rao, Professor Emeritus, Andhra University, for discussions during the progress of this work.

Spectroscopy Res. Labs., C. G. RAMA RAO,  
Andhra University, C. SANTHAMMA.  
Waltair, December 5, 1967.

1. Heath, G. A., Thomas, L. F. and Sheridan, J. *Trans. Faraday Soc.*, 1954, **50**, 779.
2. Burrus, C. A. and Gordy, W., *J. Chem. Phys.*, 1957, **26**, 391.
3. Kivelson, D. and Wilson, E. B., *Ibid.*, 1952, **20**, 1575, *Ibid.*, 1953, **21**, 1229.
4. Dowling, J. M., Meister, A. G. and Gold, R., *J. Mol. Spectry.*, 1957, **1**, 265; *Ibid.*, 1958, **2**, 9; *Ibid.*, 1958, **2**, 411.
5. Venkateswarlu, K. and Sathianandan, K., *Zeit. für Physikalische Chemie*, 1961, **218**, 318.
6. Rama Rao, C. G. and Santhamma, C., *J. Mol. Spectry.*, 1967, **22**, 236.

## CADMIUM (II) COMPLEXES

THE chelating ligands *ortho*-phenanthroline, 2-2'-dipyridyl and 2-picolyamine having N—C—N chelating group in common, are known to form *tris*, *bis* and *mono* complexes with transition metal ions.<sup>1,2</sup> Whereas the former two types are studied in detail, few examples of *mono* complexes have been reported.<sup>3-6</sup> This communication reports the

synthesis and characterisation of a few four co-ordinated *mono* complexes of cadmium (II) halide with the above ligands.

For the preparation of the complexes, ethanolic solutions of stoichiometric quantities of cadmium (II) chloride and the appropriate ligand was refluxed for half-an-hour. The separated white crystalline compounds were filtered off, washed with ethanol and dried in a desiccator over  $\text{CaCl}_2$ .

Bivalent cadmium ion has a completely filled  $d^{10}$  electronic configuration and usually forms perfect tetrahedral complexes utilising  $5\text{ sp}^3$  hybrid orbitals for bonding, leaving a perfectly symmetrical  $d_{\gamma^2}d_{\epsilon^2}$  non-bonding shell which causes least perturbation to the preferred tetrahedral stereochemistry.

The isolated complexes are listed in Table I. The purity of the isolated compounds

TABLE I  
Analytical data of cadmium (II) complexes

Compound	% Cadmium		% Nitrogen		% Chlorine	
	Found	Reqd.	Found	Reqd.	Found	Reqd.
<i>Ortho</i> -phenanthroline- $\text{C}^*$	30.4	30.8	7.6	7.7	19.8	19.5
5-Nitro <i>ortho</i> -phenanthroline- $\text{C}^*$	27.0	27.4	10.0	10.2	17.2	17.4
2, 9-Dimethyl- <i>ortho</i> -phenanthroline- $\text{C}^*$	28.3	28.6	7.0	7.1	18.0	18.1
2,2'-Dipyridyl- $\text{C}^*$	33.4	33.0	8.3	8.2	21.2	20.9
2-Picolylamine- $\text{C}^*$	38.0	38.4	9.8	9.6	24.7	24.4

Where  $\text{C}^*$  Cadmium (II) chloride.

was established by estimating the metal by complexometric titration with EDTA. The halogen was estimated as silver halide after digesting with  $\text{HNO}_3$  and nitrogen was determined by semi-micro Duma's combustion technique. The magnetic susceptibility measurements of the complexes were made over solid specimens at room temperature by the Gouy method and all the complexes were found to be diamagnetic. The poor solubility of the complexes in common solvents did not permit any evaluation of molecular complexity and electrical conductance. On the basis of percentage of metal, nitrogen and halogen, the general molecular formula can be represented as  $[\text{Cd X}_2 (\text{amine})]$ , showing that only one molecule of chelating amine is added per molecule of cadmium (II) chloride. The complexes are very stable and do not decompose on heating at  $120^\circ\text{C}$ . for hours. Analytical

data and diamagnetism of the complexes suggest presumably a tetrahedral structure for these complexes.

The generality of the synthetic approach is being extended to other metallic ions including zinc (II) and will be published in due course.

The author wishes to express his sincerest thanks to Dr. R. L. Dutta and Prof. S. K. Siddhanta for encouragement. A generous gift of 5-nitro-*ortho*-phenanthroline and 2, 9-dimethyl-*ortho*-phenanthroline by G. Froderick and Smith Chemical Co., Columbus (U.S.A.), is gratefully acknowledged.

Inorganic Chemistry Lab., A. SYAMAL.  
University of Burdwan,  
Burdwan, West Bengal, October 30, 1967.

1. Brandt W. W., Dwyer, F. P. and Gyarsas, *Chem. Revs.*, 1954, **54**, 960.
2. Sutton G. J., *Aust. J. Chem.*, 1961, **14**, 37, 550; 1962, **15**, 232, 563; 1963, **16**, 1134.
3. Wilkins, R. G. *et al.*, *J. Chem. Soc.*, 1957, p. 4514; 1959, p. 3308.
4. Harris, C. M. and Lockyer, T. N., *Chem. and Ind.*, 1958, p. 1231.
5. Broomhead, J. A. and Dwyer, F. P., *Aust. J. Chem.*, 1961, **14**, 250.
6. Syamal, A., *J. Ind. Chem. Soc.* (in press).

#### SUBNORMAL MAGNETIC MOMENTS OF $\text{Co(II)}$ AND $\text{Ni(II)}$ THIOUREA COMPLEXES

Metal complexes of thiourea, isolated from aqueous media, have been extensively studied<sup>1, 5</sup> in the recent past. However, Swaminathan and Irving<sup>2</sup> were the first to have reported isolation and IR studies on  $\text{Co(II)}$ ,  $\text{Ni(II)}$  complexes of thiourea, isolated from non-aqueous media. So far no attempt has been made to study the magnetic behaviour of these complexes, which is recorded in the present communication.

The yellow-coloured  $\text{Ni(II)}$  complex conforms to the formula  $[\text{Ni}(\text{tu})_4\text{Cl}_2]$ , where tu stands for thiourea, and shows a  $\mu_{\text{eff.}}$  = 2.77 B.M. It is well known that spin-free, octahedral  $\text{Ni(II)}$  complexes show a magnetic moment around 3.2 B.M. which is more than the spin only value (2.83 B.M.) due to mixing of upper levels *via* spin-orbit coupling.<sup>8</sup> However, the present complex exhibits a subnormal magnetic moment. According to ligand field theory, the square-planar diamagnetic  $\text{Ni(II)}$  complexes tend to become paramagnetic if two ligand atoms are brought towards the central  $\text{Ni(II)}$  atom from Z-direction. X-ray studies<sup>6</sup> have shown



that the two chlorine atoms in the complex are at a longer distance from the Ni(II) atom than expected. Hence the tetragonal (square-planar) distortion can be conceived of causing the reduction in magnetic moment.

The blue-coloured Co(II) complex is characterised<sup>2</sup> as  $[\text{Co}(\text{tu})_2\text{Cl}]$ , Cl exhibiting a magnetic moment 2.84 B.M. The tetrahedral Co(II) complexes (Blue) are known to exhibit magnetic moment around 4.2 B.M. (having three unpaired electrons,  $\text{sp}^3$  hybridisation). The subnormal magnetic moment observed in the present case may be due to covalency factor<sup>7</sup> ( $f^2$ ) arising out of partial overlap of  $\sigma$  and  $\pi$  orbitals of sulphur atom in the ligand (tu), i.e.,  $f^2 = f_{\sigma}^2 \cdot f_{\pi}^2$ .

Dept. of Chemistry, J. P. SHARMA.  
University of Allahabad, J. D. PANDEY.  
Allahabad (India), December 26, 1967.

1. Yamaguchi, A., Penland, R. B., Mizushima, S., Lane, T. J., Curran, C. and Quagliano, J. V., *J. Am. Chem. Soc.*, 1958, **80**, 527.
2. Swaminathan, K. and Irving, H. M. N. II., *J. Inorg. Nucl. Chem.*, 1954, **26**, 1291.
3. Gosavi, R. K. and Rao, C. N. R., *Ibid.*, 1967, **29**, 1937.
4. Flint, C. D. and Goodgame, M., *J.C.S. (A)*, 1966, p. 744.
5. Holt, S. L. and Carlin, R. L., *J. Am. Chem. Soc.*, 1964, **86**, 3017.
6. Nardelli, M., *Gazzetta*, 1959 **89**, 1616.
7. Owen, J., *Proc. Roy. Soc.*, 1955, p. 183.
8. Lewis, J., Nyholm, R. S. and Smith, P. W., *J.C.S. (A)*, 1961, p. 4590.

### STERIC EFFECTS IN ACID HYDROLYSIS OF NITROPHENYL ESTERS

THE kinetics of hydrolysis of various phenyl esters was investigated by several workers<sup>1-6</sup>. These studies were mostly undertaken to evaluate the catalytic efficiency of various nucleophilic catalysts in relation to their structure or nucleophilicity. Not much work was done on the influence of substituents near the reaction centre on the rate. Fife<sup>7</sup> has studied the hydrolysis of *p*-nitrophenyl esters ( $p\text{-O}_2\text{N.C}_6\text{H}_4\text{O.O.C.R}$ ) by imidazole and found qualitatively that increasing the number of methyl groups in R results in retardation of the rate to a greater extent. Chenevry<sup>8</sup> has evaluated the polar and steric effects in the uncatalyzed and benzimidazoles catalyzed hydrolysis of *para* nitrophenyl esters with widely differing substituents. There was no reference in the literature to the acid hydrolysis of nitrophenyl esters, especially the *ortho* ester. The authors

have therefore undertaken the study of the influence of various factors on the acid hydrolysis. The effect of the polarity of the solvent and the acidity on the reaction rate was reported elsewhere.<sup>9</sup> The present investigation deals with the acid hydrolysis of *para* and *ortho* nitrophenyl esters ( $\text{O}_2\text{N.C}_6\text{H}_4\text{O.O.C.R}$ ) where  $\text{R} = \text{CH}_3\text{-}$ ,  $\text{C}_2\text{H}_5\text{-}$ ,  $\text{C}_3\text{H}_7\text{-}$  and  $i\text{-C}_4\text{H}_9\text{-}$ . This investigation was undertaken to test the applicability of Taft's<sup>10</sup> linear steric energy relation and to evaluate the reaction constant  $\delta$ , for the series under study.

**Materials.**—Except acetates, all the other esters were prepared by the method of Fife<sup>7</sup> using the respective acid chlorides prepared by the method suggested by Cason.<sup>11</sup> The acetates were prepared by the method of Chattaway.<sup>12</sup> The purity of all the esters was ascertained by their melting points and their infra-red spectra. All other reagents used were of Analytical Reagent quality.

**Kinetic Measurements.**—The kinetic studies were made in different solvent mixtures, "20% methanol" and "20% acetone". The acid concentration was maintained at 3 M in HCl. The reaction was followed spectrophotometrically using Hilger Uvispek instrument. The changes in optical density with time were measured at the wavelengths mentioned. *Para* ester in methanol at 255  $\text{m}\mu$ ; *ortho* ester in methanol at 255  $\text{m}\mu$ ; *para* ester in acetone at 320  $\text{m}\mu$ ; *ortho* ester in acetone at 350  $\text{m}\mu$ . The details of the experimental procedure are the same as those reported earlier.<sup>9</sup> The rate constants were calculated using first order rate equation and the results are given in Table I.

Taft<sup>10</sup> in 1953 proposed equation (1) for the steric effects of substituents near the reaction centre for the reaction series for which Hammett's  $\rho$  value and the range of polar substituent constant ( $\sigma^*$  values) for the substituents are small.

$$\log \left( \frac{k}{k_0} \right) = \delta E_s \quad (1)$$

where  $k_0$  = specific rate for the ester,  $\text{R} = \text{CH}_3\text{-}$ ,  $k$  = the specific rate for other esters,  $E_s$  = the steric substituent constant, and  $\delta$  = reaction constant which is independent of the nature of the substituent and is a relative measure of the susceptibility of the reaction series to the steric requirements of the substituents.

When  $\log (k/k_0)$  values are plotted against  $E_s$  values<sup>10</sup> good straight line plots are obtained as required by equation (1). This indicates that Taft's linear steric energy relationship holds in the reaction series under study. The  $\delta$ -values

TABLE I

R	E <sub>s</sub>	log ( $k/k_0$ *) at 35° C.			
		<i>Para</i> esters		<i>Ortho</i> esters	
		20% Methanol	20% acetone	20% Methanol	20% Acetone
CH <sub>3</sub> -	.. 0.00	0.0	0.0	0.0	0.0
C <sub>2</sub> H <sub>5</sub> -	.. -0.07	-0.076	-0.050	-0.281	-0.118
C <sub>3</sub> H <sub>7</sub> -	.. -0.36	-0.247	-0.222	-0.452	-0.360
<i>i</i> -C <sub>4</sub> H <sub>9</sub> -	.. -0.93	-0.635	-0.608	-0.942	-0.835
		*log $k_0$ = -3.2154	*log $k_0$ = -3.3354	*log $k_0$ = -3.9971	*log $k_0$ = -3.8309

obtained in the present work along with the  $\delta$ -values<sup>8</sup> in the literature for the reaction series uncatalyzed and catalyzed by benzimidazoles are presented in Table II. The  $\delta$ -value

TABLE II

$\delta$ -Values for reaction series under different conditions

Catalyst	Temperature °C.	Solvent	Esters	
			<i>Para</i>	<i>Ortho</i>
3 M HCl	28	20% Methanol	0.659	0.779
3 M HCl	30	20% Acetone	0.649	0.844
3 M HCl	35	20% Methanol	0.643	0.773
3 M HCl	35	20% Acetone	0.650	0.824
Uncatalyzed <sup>(*)</sup>	30	29.5% Ethanol	0.579	..
Benzimidazole <sup>(*)</sup>	30	29.5% Ethanol	1.060	..
2-Methyl benzimidazole <sup>(*)</sup>	30	29.5% Ethanol	1.590	..

\* Phosphate buffer at "pH" 7.95.

for the *para* ester in the present investigation lies in between the values for the uncatalyzed and catalyzed by benzimidazoles. This observation along with the higher  $\delta$ -value for *ortho* nitro series as compared to  $\delta$ -value for *para* nitro series (cf. Table II) suggests that steric blocking of the carbonyl group by the substituents and thus hindering the attack of the nucleophile at carbonyl carbon is responsible for the decrease in the rate. There is no appreciable change in  $\delta$ -value with change of solvent medium or with rise of temperature as shown in Table II. This may indicate that there is no change in mechanism of the reaction either with rise of temperature or change of solvent.

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Department of Chemistry, V. RANGAIAH.  
Sri Venkateshwara Univ. S. BRAHMAJI RAO.  
College,

Tirupati, S. India, November 20, 1967.

1. Bender, M. L. and Turnquest, B. W., *J. Am. Chem. Soc.* 1957, **79**, 1652, 1656.
2. Bruce, T. C. and Schmir, G. L., *Ibid.*, 1957, **79**, 1663.
3. — and Lapinaski, R., *Ibid.*, 1958 **80**, 2265.
4. Jencks, W. P. and Carriuolo, S., *Ibid.*, 1960, **82**, 1778.
5. Bender, M. L., Pollock, E. J. and Neven, M. C., *Ibid.*, 1962, **84**, 595.
6. Sacher, E. and Laidler, K. J., *Can. J. Chem.*, 1964, **42**, 2404.
7. Fife, T. H., *J. Am. Chem. Soc.*, 1965 **87**, 4597.
8. Chenevey, E. C., *Ph.D. Thesis*, Case Institute of Technology, Michigan, 1963.
9. Rangaiah, V. and Brahmaji Rao, S., *Ind. J. Chem.*, 1967, **5**; 483 (in press).
10. Taft, R. W. Jr., *Steric Effects in Organic Chemistry*, Edited by Newman, John Wiley & Sons, Inc., New York 1956, p. 586.
11. Cason, J. and Rapoport, H., *Basic Experimental Organic Chemistry*, Prentice-Hall, Inc., New Jersey, 1962, p. 84.
12. Chattaway, F. D. *J. Chem. Soc.*, 1931, p. 2495.

### CHEMICAL COMPONENTS OF XANTHORIA ELEGANS

THE Indian lichen, *Xanthoria elegans* (*Caloplaca elegans*) was investigated earlier<sup>1</sup> and physicon was reported as only component. In view of the later observation that *X. fallax* of Japanese origin had other components<sup>2</sup> also, re-investigation of *X. elegans* has been made using a sample collected from Pahalgam (Kashmir) where it grows on rocks near the banks of the river Lidder. Its collection is difficult and hence its study has been carried out with a small sample. Complete extraction of the lichen (50 g.) in the hot with chloroform and concentration of the extract yielded a deep brownish-yellow residue (1 g.). It was found to be a mixture of several components by TLC (silica gel. G; ethyl formate, formic acid, toluene: 4, 1, 5). Separation of this mixture by fractional crystallisation using various organic solvents was unsuccessful. Murakami<sup>3</sup> used MgCO<sub>3</sub>-Na<sub>2</sub>SO<sub>4</sub> column for the separation of quinones from *X. fallax* followed by repeated chromatography on CaHPO<sub>4</sub>. In the

present study silica gel has been found to be quite suitable. The crude concentrated extract was passed through a column of silica gel prepared in benzene and developed using chloroform whereby four distinct zones could be seen. The lowermost was eluted with benzene and on crystallisation from methanol, gave yellowish-brown needles (500 mg.), m.p. 205-06°. It was identified as physcion;  $\lambda_{\text{max.}}^{\text{C}_2\text{H}_5\text{OH}}$  450, 282, 264 and 252 m $\mu$ . It was closely followed by another fraction which was found to be a mixture of physcion and a small amount of a closely related substance and it could not be separated by repetition of this chromatography. A second prominent ring was also eluted by benzene and recrystallisation of the product from methanol afforded orange yellow needles (50 mg.), m.p. 246-47° (Found: C, 64.5; H, 3.9. Calculated for  $\text{C}_{16}\text{H}_{10}\text{O}_6$ : C, 64.4; H, 3.4%);  $\lambda_{\text{max.}}^{\text{C}_2\text{H}_5\text{OH}}$  425, 340, 280, 264 and 244 m $\mu$ . It gave a brown colour with ferric chloride, pink colour with magnesium acetate and violet colour with sodium hydroxide. It formed an acetate which crystallised from methanol as pale yellow needles, m.p. 170°. All these properties suggested that the compound was fallacinal (lit. m.p. 250-51°, acetate m.p. 170°). The identity was confirmed by its I.R. spectrum which agreed in all respects with the one reported for fallacinal by Murakami.<sup>2</sup> Subsequent elution of column with benzene-chloroform mixture (4:1) gave a component which crystallized from methanol as brownish-yellow needles (300 mg.), m.p. 238-39°. The m.p. remained unchanged after purification through its acetate (Found: C, 63.9; H, 4.2. Calculated for  $\text{C}_{16}\text{H}_{12}\text{O}_6$ : C, 64.0; H, 4.0%). With magnesium acetate it gave a pink colour and with sodium hydroxide a violet precipitate  $\lambda_{\text{max.}}^{\text{C}_2\text{H}_5\text{OH}}$  430 m $\mu$ . The I.R. spectrum of this component and the one reported for teloschistin were superimposable. It gave an acetate which crystallised from aqueous methanol as pale yellow needles, m.p. 192-93°. The compound was identified as teloschistin. There is some discrepancy in the literature regarding the m.p. of teloschistin. Murakami<sup>2</sup> recorded the m.p. as 236-37°. Seshadri and co-workers<sup>3,4</sup> purified the natural and synthetic samples through their acetates and reported the m.p. of teloschistin as 245-47°. Earlier samples of teloschistin are not available for comparison. The m.p. of the acetate has presented no discrepancy.

Final elution of the column with methanol gave small amount of a pink-coloured product (30 mg.). Its colour reactions with ferric chloride, magnesium acetate and alkali and its T.L.C. showed it to be a mixture of three related quinones not identical with those mentioned above.

*Teloschistes* and *Xanthoria* have fractions of related compounds of different oxidation-reduction stages; but they vary in their proportions. Earlier sample<sup>3</sup> of *T. flavicans* had physcion and teloschistin in the proportion of 8:1 while the sample collected later<sup>5</sup> gave physcion and fallacinal in the ratio of 4:1. *Xanthoria fallax*<sup>2</sup> contained physcion and fallacinal, 8:1 while teloschistin was present in very poor yield. The *X. elegans* now examined has provided physcion, teloschistin and fallacinal in the proportions 10:6:1 and may prove to be a reliable natural source for teloschistin.

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Dept. of Chemistry,  
University of Delhi,  
December 10, 1967.

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T. R. SESHADRI.

1. Neelakantan, S. and Seshadri, T. R., *J. Sci. and Ind. Res.*, 1952, **11 B**, 126.
2. Murakami, T., *Chem. Pharm. Bull.*, 1956, **4**, 298.
3. Seshadri, T. R. and Subramanian, S. S., *Proc. Ind. Acad. Sci.*, 1949, **30 A**, 62.
4. Neelakantan, S. and Seshadri, T. R., *J. Sci. and Ind. Res.*, 1954, **13 B**, 884.
5. Rajagopalan, T. R. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1959, **49 A**, 1.

#### SEPARATION OF SOME HETEROCYCLIC AMINES USING BUFFERED PAPER

BUFFERED paper chromatography has been widely used for separation of a variety of organic compounds. Mention may be made here of the work of Partridge and Swain,<sup>1</sup> Blackburn,<sup>2</sup> Felix and Kerkels,<sup>3</sup> who have improved the use of buffered papers for separation of amino-acids. Strongly basic substances such as Solanaceous and Ergot alkaloids have also been separated on paper buffered at acidic pH.<sup>4</sup>

Even though good separation is brought about without the use of buffered papers in many cases, very often compounds having very close structures and  $R_f$  values present difficulties in their separation. One such series of

compounds is quinoline and acridine amines, which are found to have very close  $R_f$  values.<sup>7</sup> The present workers therefore have explored in this communication the possibility of extending buffered paper technique to the above-mentioned amines. It has been thus observed that using a pH 3.3 buffered paper (MacIlvaine's buffer solution)<sup>6</sup> good separation of quinoline and acridine amines present together or separately can be achieved. The Whatman No. 1 paper was dipped in the MacIlvaine's buffer (pH 3.3) and was dried at room temperature. The amines were applied in the range of 5-30  $\gamma$  in all the cases over fully dried paper, which was then allowed to balance in chamber atmosphere of solvent vapours for 30 minutes before irrigation.

*n*-Butanol and *n*-propanol when used in a chamber presaturated with water vapour alone, gave the desired separation. The chromatograms were run in ascending direction for 10 hr. and Dragendorff's<sup>7</sup> reagent was used as a developer, causing deep orange and yellowish orange spots for quinoline and acridine amines respectively. The  $R$  values and other pertinent details are given in Table I.

TABLE I

Amino derivatives	$R_f \times 100$		Colour with Dragen- dorff's reagent
	<i>n</i> -butanol	<i>n</i> -propanol	
1 4-2 (dimethylamino ethyl amino) quinoline oxalate	40	31	Deep orange
2 4-2 (1-pyrrolidine) ethyl amino quinoline dioxalate	31	27	"
3 4-2 (4-morpholine) ethyl amino quinoline dioxalate	35	23	"
4 9 (2-dimethylamino ethyl-amino) acridine dihydrochloride	60	55	Yellowish-orange
5 9-2 (1-pyrrolidine) ethyl amino acridine hydrochloride	66	57	"
6 9-2 (4-morpholine) diethyl-amino acridine hydrochloride	23	52	"

It is evident from Table I that the  $R_f$  value are higher with *n*-butanol than with *n*-propanol and a greater resolution of compounds can be achieved with such buffered paper than with unbuffered paper where their  $R_f$  values are close. In this way it is possible now to resolve and identify all the acridine and quinoline amines with a fair amount of accuracy. Furthermore this method provides satisfactory results with a single solvent system.

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Organic Chemistry Division, S. M. DESHPANDE,  
Department of Chemistry, R. R. UPADHYAY,  
Banaras Hindu University,  
Varanasi-5, September 4, 1967.

1. Partridge, S. M. and Swain, T., *Nature*, 1950, **166**, 272.
2. Blackburn, S., *Biochem. J.*, 1951, **48**, 126.
3. Felix, K. and Krekels, A., *Hoppe-Seyler's Z. Physiol. Chem.*, 1952, **290**, 79.
4. Carless, J. E. and Woodhead, H. B., *Nature*, 1951, **168**, 233.
5. Deshpande, S. M. and Upadhyay, R. R., *Curr. Sci.*, 1967, **36**, 374.
6. MacIlvaine, T. S., *J. Biol. Chem.*, 1921, **49**, 183.
7. Block, R. J., Durrum, E. L. and Zweig, G., *A Manual of Paper Chromatography and Electrophoresis*, Academic Press, New York, 1958, p. 361.

#### TOTAL SOLUBLE CARBOHYDRATES AND REDUCING SUBSTANCES OF SOME LEGUMINOUS SEEDS

Five varieties of edible *Phaseolus* seeds and one of wild inedible seeds of *Erythrina indica* were analysed qualitatively for their sugar content and quantitatively for their total soluble carbohydrates at room temperature ( $27 \pm 3^\circ \text{C}$ .) as well as at  $100^\circ \text{C}$ .

The five *Phaseolus* seeds were bought from bazaar and identified. Seeds of *Erythrina indica* were collected from the Botany Department Garden of the Allahabad University and analysed for their proximate composition employing the usual methods described in previous communications<sup>1-3</sup> from this laboratory.

For the qualitative analysis of soluble sugars, paper-partition chromatography of Consden, Martin and Gordon, as described by Partridge was followed. The below-noted solvent systems were employed:

1. Ethylacetate-Pyridine-Water<sup>4</sup> (2 : 1 : 2)
2. Ethylacetate-Pyridine-Water<sup>1</sup> (12 : 5 : 4)
3. Propan-1-ol-Ethylacetate-Water<sup>5</sup> (7 : 1 : 2)
4. Butan-1-ol-Acetic acid-Water (4 : 1 : 5)

Extraction of seed powders for the determination of total soluble carbohydrates and total reducing substances was made by following two procedures.

**Method A:** The seed-meal (1 g. ca) was mechanically shaken in an Erlenmeyer flask with distilled water (25 ml.) for two hours and the extract was subsequently centrifuged. The supernatant (1 ml.) was diluted to 100 ml. with distilled water and aliquots were used for colour development.

Method B: Alternatively, the seed powder (1g. ca) was repeatedly extracted with distilled water and centrifuged till the supernatant was negative to Molisch's test. The combined supernatant was made up to 100 ml. 5 ml. of this was diluted to 100 ml. and aliquots were employed for the two assays.

Total soluble carbohydrates were estimated by the method of Trevelyan and Harrison and total reducing substances by the method of Hagedorn and Jensen as described by Hawk, Oser and Summerson<sup>6</sup> and modified by Howden and Kilby.<sup>7</sup>

Table I records the preliminary chemical composition of the five *Phaseolus* seeds and Table II their total water-soluble carbohydrates

TABLE I  
Chemical composition of some *Phaseolus* seeds  
(Expressed as percentage on dry-weight basis)

Constituent	Seed *				
	1	2	3	4	5
Moisture (%) ..	11.89	12.90	9.90	11.20	10.16
Ash (%) ..	3.74	4.35	3.81	3.41	3.62
Fat (ether extrac- tives) (%)	1.59	1.80	2.35	1.69	2.78
Crude protein (N × 6.25)	27.78	28.91	35.10	28.21	25.76
Non-protein nitro- gen	0.33	0.27	0.36	0.22	0.21
Crude fibre ..	1.7	1.5	1.15	3.21	3.46
Minerals (mg./ 100 g.):					
Calcium ..	139	121	188	131	112
Phosphorus ..	476	351	431	395	493
Iron ..	8.1	6.3	9.8	7.1	10.6

\* Seed: 1. *Phaseolus vulgaris* I  
2. " " II  
3. " " III  
4. *Phaseolus mungo*  
5. *Phaseolus aconitifolius*

TABLE II  
Total soluble carbohydrates and total soluble  
reducing substances at 100° C.

(Expressed in terms of g. glucose/100 g. seed powder)

Seed	Total soluble carbohydrates	Total soluble reducing substances
<i>Phaseolus vulgaris</i> I ..	20.08	3.82
" " II ..	17.91	3.28
" " III ..	16.42	5.32
<i>Phaseolus mungo</i> ..	22.98	3.67
<i>Phaseolus aconitifolius</i> ..	13.92	2.35
<i>Erythrina indica</i> ..	12.02	2.80

and total reducing substances at 100° C. The figures obtained indicate that all the five seeds are nutritionally adequate sources of proteins,

carbohydrates and minerals. Qualitative analysis for free-soluble sugars revealed the presence of glucose and sucrose in all seeds except *Erythrina indica* and *Phaseolus aconitifolius* seeds which showed the presence of raffinose in addition.

The total soluble carbohydrates and total reducing substances estimated at room temperature seem to be more or less in equal proportions. The range of variation of total soluble carbohydrates by methods A and B is found to be respectively between 5.56-6.90 g. and 5.52-6.70 g. whereas for the total reducing substances it falls respectively between 1.63-2.37 g. and 1.62-2.36 g. in terms of glucose/100 g. of seed powder.

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Biochemistry Section, RADHA PANT.  
The University, D. R. P. TULSIANI.  
Allahabad, October 10, 1967.

1. Pant, R. and Kapur, A. S., *Ann. Biochem. Exptl. Med.*, 1963, **23**, 95.
2. — and —, *Ibid.*, 1963, **23**, 95.
3. — and Bishnoi, P. L., *Curr. Sci.*, 1967, **14**, 376.
4. Hermyn, M. A. and Isherwood, F. A., *Biochem. J.*, 1949, **44**, 402.
5. Albon, N. and Groos, D., *Analyst*, 1952, **77**, 410.
6. Hawk, P. B., Oser, B. L. and Summerson, W. H., *Practical Physiological Chemistry*, Churchill, London, 1954, p. 578.
7. Howden, G. F. and Kilby, B. A., *J. Insect. Physiol.*, 1960, **4**, 218.

## ON INTERPENETRATION TWINNING IN PIGEONITE

THE dolerite dykes in M.P.R. Project area in Anantapur District of Andhra Pradesh have been found to show certain interesting features, particularly with respect to pyroxene twinning (Prasad and Naidu, 1966 and 1967). In one of these dykes, about two miles north-west of Sivarampet, pigeonite exhibits interpenetration twinning. The interpenetration twinning in augite has been recorded by Jaffe (1953), but the reported occurrence of interpenetration twinning in pigeonite has not been found in literature, accessible to the authors. This dyke intrudes a medium- to coarse-grained granite with an average width of ten feet and runs for a distance of about two miles. It shows sharp, well-defined and chilled contacts with the country rock. It is a fine-grained, dense and dark rock with specific gravity of 3.01.

Under the microscope, the rock is seen to be made up of ground mass (82.96%), plagioclase (9.27%) and pyroxene (7.77%). Plagioclase (An: 60-65%) occurs as tiny, twinned laths. The microlites show somewhat crude but distinct preferred orientation, as the longer axes of the microlites show more or less the same trend. Augite ( $ZAC = 40-44^\circ$ ,  $2V_z = 40-46^\circ$ ,  $N_z - N_x = 0.022-0.024$ ), and pigeonite occurs as individual grains and in glomeroporphyritic clusters. Elongation parallel to C-axis is common but all variations are encountered from slender prisms to stout crystals.

Both plagioclase and pigeonite show interpenetration twinning. In both cases, each arm of the interpenetration twin is again a twinned grain. Of the pigeonite cross (Fig. 1) one arm is 0.45 mm. in length and 0.15 mm. in breadth, while the other arm is also of the same length and 0.125 mm. in breadth. It has the following optical characters:

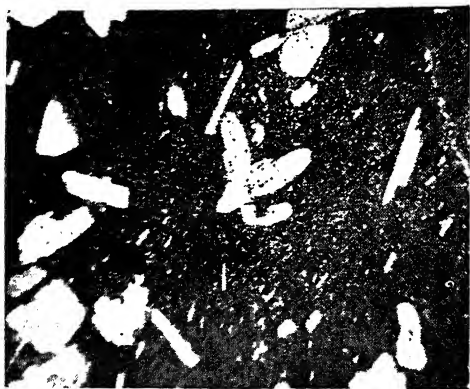


FIG. 1

Colourless, non-pleochroic, positive elongation. XZ  $010$ ,  $ZAC = 32^\circ$ ,  $N_z - N_x = 0.025$ . The optic axial angle is very low, as indicated by the slight breaking up of the uniaxial cross.

The two individual twins, forming the cross, are contact twins with  $[100]$  as twin plane and the angle between the two twin planes is  $80^\circ$ . The interpenetration twin has  $[101]$  as twin plane. The interpenetration twin of plagioclase has, as its arms, two simple twins of which one is twinned after albite law, while the other is twinned after carlsbad law.

Gorai (1951) divides plagioclase twins into four types and interpenetration twins are grouped under type 4; these include twins according to the laws that are restricted to, or characteristic of the volcanic as well as plutonic rocks. In the dyke, under study, pigeonite, which is a product of rapid crystallisation and

which is restricted to lavas and other relatively quickly chilled rocks, occurs as interpenetration twins. Hence interpenetration twin of plagioclase, which is associated with twinned and untwinned pigeonite, appears to be restricted to, and characteristic of volcanic rather than plutonic rocks. It may be concluded that the chilled nature, basaltic texture, presence of pigeonite and the occurrence of the interpenetration twinning in both plagioclase and pigeonite suggest that the dyke, under study, has developed under conditions similar to those attained in the volcanic mode of origin.

Department of Geology,  
S.V. University,  
Tirupati, October 27, 1967.

E. A. V. PRASAD,  
M. G. C. NAIDU.

1. Gorai, M., *Amer. Min.*, 1951, **36**, 884.
2. Jaffe, H. W., *Ibid.*, 1953, **38**, 1071.
3. Prasad, E. A. V. and Naidu, M. G. C., "On Pyroxene Twinning (abstract, p. 34)—Mafic and ultramafic rocks of India," U.G.C. Seminar held at Csmatia University, Hyderabad, 1966.
4. — and —, *Curr. Sci.*, 1967, **36**, 479.

#### TITANIA CONTENT OF SOME ULTRAMAFIC ROCKS OF SOUTH INDIA AND ITS SIGNIFICANCE

The titanium content of a primary mafic rock appears to be a good measure of its "primitiveness" or the degree of differentiation, as could be seen from Table I. This concept is consistent with the observation that  $Ti^{+4}$  is enriched in the crust relative to the earth to the extent of 2-10% (Taylor<sup>1</sup>).

The titania contents of a suite of 13 ultramafic rocks drawn from the poly-metamorphic Eastern Ghats belt of Southern India have been determined with a "Lumetron" photoelectric colorimeter by the peroxide method of Riley.<sup>6</sup> The titanium content is estimated on the basis of the colour transmission through the yellow compound formed with hydrogen peroxide, at the wavelength of 415 mμ. The interference of iron is suppressed by employing phosphoric acid. The results are given in Table II.

Judged by the criterion cited in Table I, some of the samples (A18, A23, A27, A29, A32) may conceivably be approximations of the upper mantle in composition. Work is under way to estimate ratios like  $Fe_2O_3/FeO$ ,  $Sr^{87}/Sr^{86}$ ,  $Pb^{208}/Pb^{204}$ , etc., in these rocks to make the result a little more definitive.

The financial assistance of CSIR is thankfully acknowledged. The authorities of the

TABLE I

S. No.	Material	Geological significance	TiO <sub>2</sub> %	Reference
1	Type I Carbonaceous Chondrites (Orgueil)	Probable composition of premordial dust cloud from which the earth was formed by accretion	0.07	Wiik <sup>2</sup>
2	Basaltic achondrites ..	Probable composition of the upper mantle	0.48	Urey and Craig <sup>3</sup>
3	"Pyrolite" (Comp.: Olivine 80%; Orthopyroxene 19.3%; Chromespinel 0.70%)	Presumed composition of the upper mantle	0.71	Ringwood <sup>4</sup>
4	Oceanic tholeiite ..	Less differentiated derivative from the upper mantle	1.51	Engel <i>et al.</i> <sup>5</sup>
5	Alkali basalt ..	More differentiated derivative from the upper mantle	2.91	Engel <i>et al.</i> <sup>5</sup>

TABLE II

S. No.	Specimen No.	Description	Location	TiO <sub>2</sub> %
1	A 3/65	"Basic" charnockite (Hypersthene-Gabro)	Kondapalle, Kistna Dt. (A.P.) (16° 35' 30" N; 80° 31' 20" E.)	1.07
2	A 7/65	Amphibolite	do.	0.25
3	A17/65	do.	Sittampundi, Salem Dt. (Madras) (11° 15' 0" N; 77° 54' 0" E.)	0.15
4	A18/65	Hornblende Eclogite	do.	0.37
5	A19/65	Pyroxenite	do.	0.20
6	A21/65	Amphibolite	do.	0.15
7	A22/65	do.	do.	0.25
8	A23/65	Garnet pyroxene-Hornblende-gneiss	do.	0.88
9	A25/65	Pyroxenite	do.	0.20
10	A27/65	Eclogite	do.	0.50
11	A29/65	Garnetiferous Amphibolite	do.	0.42
12	A32/65	Eclogite	Pavittam, Salem Dt. (Madras) (11° 6' 0" N; 78° 16' 20" E.)	0.32
13	A34/65	Dunite	do.	0.15

Analyst: G. S. R. Sastry

Neyveli-Salem Steel Project kindly provided facilities for field-work.

The work reported in this note was undertaken as a part of the Indian National Programme of the International Upper Mantle Project.

Centre of Advanced G. S. R. SASTRY.  
Study in Geology, U. ASWATHANARAYANA.  
University of Saugar,  
Sagar (M.P.), November 20, 1967.

#### AN ACCOUNT OF A RICH FLUORITE DEPOSIT AT HINGORIA, BROACH DT., GUJARAT STATE

THE fluorite deposit at Amba Dongar related to carbonatite evoked great interest in the search for minerals of economic importance. The deposit of fluorite now discovered at Hingoria has a similar geological setting. Fluorite of acid grade occurs as a thick vein in the conical hill and is associated with the Carbonatite (?) rock that has domed up the basalts.

Fluorite occurs in a hillock which lies between Lat. 21° 44'-21° 45' and Long. 73° 15'-73° 16'. The hillock appears like a mole rising to a height of 436 feet above mean sea-level and about 200 feet above the surrounding plain country. It is located half-a-mile west-north-west of the village Hingoria, which is located along the Rajpardi-Netrang bus route (about 3 miles from Rajpardi).

1. Taylor, S. R., *Geochim. et Cosmochim. Acta*, 1964, **28**, 1989.
2. Wiik, H. B., *Ibid.*, 1956, **9**, 279.
3. Urey, H. C. and Craig, H., *Ibid.*, 1953, **4**, 36.
4. Ringwood, A. E., *Ibid.*, 1966, **30**, 41.
5. Engel, A. E. J., Engel, Celeste, G. and Havens, R. G., *Geol. Soc. Amer. Bull.*, 1965, **76**, 719.
6. Riley, J. P., *Analytica Chimica Acta*, 1958, **19**, 413.

Fluorite occurs in the form of a vein with an average thickness of over two feet. It has a north-east-south-west trend dipping steeply to the north-west and plunging to the south-west. It is traceable from the top of the 436' peak towards the south-west for a distance of over 450 feet along the south-westerly slope of the hill. The north-easterly extension, if any, is covered by the talus and boulders of brecciated basalts which also contain fluorite.

Fluorite is generally massive and occasionally ill-developed cubes are seen. It is coloured in shades of violet (dominant), yellow and green. Even by the most conservative estimate, 1,000 tons of the pure mineral can be envisaged from surface indications. Association of fluorite with a Carbonatitic intrusive body postulates the continuity of the mineralised horizon much below the ground-level and large reserves of the mineral can be expected from this locality.

The country rock in which the fluorite occurs is a calcareous rock (Carbonatite?) associated with the upwarped brecciated basalts. Fragments of basalts within the calcareous rock, baking and hardening of the contact of basalts with the calcareous rock and the intrusive field relation of the calcareous rock are all strongly suggestive of the intrusive body being carbonatitic. Work on the detailed mineralogy of this is in progress.

About a mile north-west of the hillock, the Shursho hill forms another centre of volcanic eruption of alkalic rocks.

The traps of the conical hill and the Shursho hill are domed and dip at very high angles—a fact noted by Blanford<sup>1</sup> as early as 1869. The fluorite mineralisation is post-Trappean in age, genetically related to the alkalic complex, agreeing in these aspects with Amba Dongar.

Centre of Advanced  
Study in Geology,  
University of Saugar,  
December 27, 1967.

G. R. UDAS.  
P. KRISHNAMURTHY.

### THE BEHAVIOUR OF *METOPONORTHUS PRUINOSUS* (BRANDT) (PORCELLIONIDAE, PERACARIDA) IN RELATION TO HUMIDITY

Of all the arthropods living on land, woodlice are probably the most ill-equipped for living in terrestrial environments. Because of its small size and the lack of any suitable morphological specialization for the conservation of body moisture, transpiration from a woodlouse is regulated by the prevailing temperature and humidity, identical to a manner these environmental factors affect a physical body.<sup>1</sup> Also, the slightly modified gills, the main organs of respiration in these crustaceans, cannot function away from saturated conditions.<sup>1</sup>

In spite of these disadvantages, *Metoponorthus pruinus* has a world-wide distribution. It has been suggested that the survival of this species in arid regions might be due to its being able to find an optimal niche.<sup>2</sup> This implies that *M. pruinus* has the ability to detect differences in their microenvironments.

For the analysis of the humidity orientation mechanism of the woodlice, two sets of experiments were performed: (a) In the first set, a rectangular wooden case, having a glass roof, was used. A lengthwise partition of copper wire-gauze divided the case into an upper and a lower chamber. Sulphuric acid solutions of various strengths were kept in the lower chamber to create different humidity gradients near the corners of the upper chamber. An evaporimeter was used to check the humidity levels. The woodlice were introduced through a small window in one side of the upper chamber, and counts were taken of the number of woodlice found in each corner. (b) The second set of experiments was performed using a modified olfactometer,<sup>3</sup> in which various humidities were maintained by forcing a constant current of dry air over different dilutions of sulphuric acid.

The data collected clearly showed that the woodlice, both nymphs and adults, were able to perceive small differences in the experimental humidity gradients within the temperature range of 24.2°C. to 28.5°C., and had a definite preference for saturated, or nearly saturated air.

A minority of *M. pruinus*, in certain instances, was observed aggregating in less humid zones even when the choice for higher humidities was available. However, these individuals did pay frequent visits (from 4 to a

1. Blanford, W. T., "On the traps and intertrappean beds of West and Central India," *Mem. Geol. Surv. Ind.*, 1869, 6, Art. 5, Pt. II, Sec. 14, p. 191.



maximum of 10 visits during a period of 30 minutes) to the highly humid zones. Nevertheless, they spent most of their time in less humid environments. These reactions away from saturated conditions may have been for reducing the chance of "water poisoning", and perhaps of attack by fungi or other pathogenic organisms which thrive under wet conditions.<sup>5</sup>

Also, the nature of humidity reaction, in invertebrates in general, depends on the state of their water reserves. Since the majority of the individuals showing a preference for less saturated condition were in their early stages of development, they may have higher body moisture contents than the mature ones, and consequently, were least susceptible to death by desiccation. Similar reactions have been reported in certain members of the genera *Forficula*,<sup>1</sup> *Allochironomus*,<sup>2</sup> and certain species of termites.<sup>3</sup>

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Sudbury, Ontario,  
Canada, October 30, 1967.

1. Alikhan, M. A. (Unpublished).
2. Edney, E. B., *Biol. Rev. Cambridge Philos. Soc.*, 1954, **29**, 185.
3. Ernst, E., *Insectes Sociaux*, 1956, **3**, 229.
4. Perttunen, *Nature*, 1952, **170**, 200.
5. Syrjämäki, J., *Ann. Entomol. Fenn.*, 1960, **26**, 138.
6. Wilson, I. F. and Bean, J. L., *Jour. Econ. Ent.*, 1959, **52**, 621.

# METACERCARIA OF BUCEPHALOPSIS (A PROSORHYNCHINE GASTEROSTOME) IN JUVENILES OF A TOAD AND TWO CYPRINID FISHES

Adult bucephalid trematodes belonging to *Bucephalopsis* Dies, 1885 (*Prosorhynchinae* Nicoll, 1914) and *Bucephalus* Baer, 1826 (*Bucephalinae* Nicoll, 1914) occur in some of our freshwater siluroid fishes (Rai, 1967). Since the description of the life-history stages of *Bucephalus elegans* by Woodhead (1930), bucephalid metacercariae have been recorded from several countries in a number of small freshwater fishes, among others, by Dollfus (1951) and Chubrik (1952).

During investigations on metacercarial incidence in our lower vertebrates—piscine and amphibian, numerous specimens of the juveniles (with four limbs and tail) of *Bufo andersonii* Boulenger and the juveniles of the two carps, *Aspidoparia morar* (Ham.) and *Barilius ovazardi* Day, were examined during

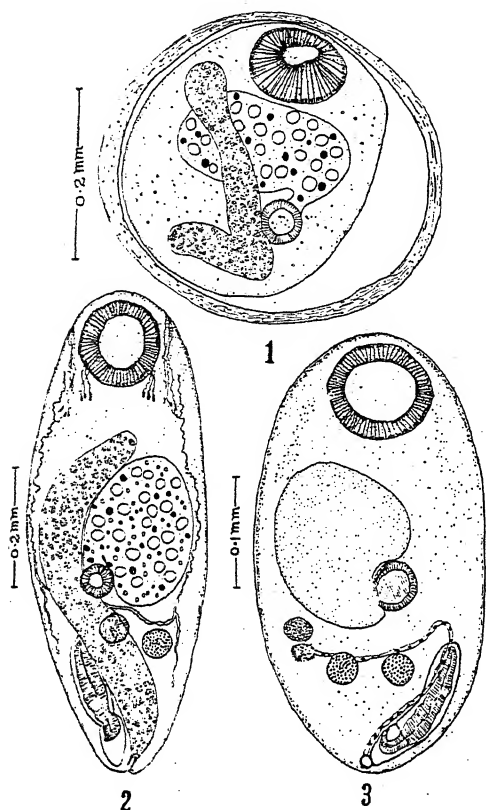
April, 1967. The collection, made from a small pond developed near the banks of river Jamuna at Mathura, was thoroughly searched for the larval helminths occurring in the musculature and viscera. Of the 157 developing toads, 46 were found to harbour, in regions of subcutaneous tissues, musculature of fore and hind legs, muscles of the eye and mesentery, an infection with bucephalid cysts.

The nearly spherical and somewhat whitish cysts measured 0.23–0.38 mm. in diameter, the cyst wall being 0.009–0.018 mm. thick. The coverslip preparations of the extracted cysts revealed the well-developed and tubular excretory bladder full of dark contents, the prominent and sub-terminal rhynchus without papillar prominences, the pharynx, and the sac-shaped intestine containing different-sized globules with a yellowish-green tinge.

The morphological details including the excretory system and the developing gonads were evident in the fresh preparations of the excysted juveniles. The elongated body, with a broader anterior end, a somewhat narrower posterior end, measured 0.63–0.88 mm.  $\times$  0.23–0.35 mm. Minute spines covered the entire cuticle. The circular and sub-terminal rhynchus measured 0.12–0.14 mm. in diameter. Four groups of unicellular glands, lying behind the rhynchus, had thin and long ducts passing laterally towards the anterior end. The mouth, situated slightly behind the middle of the body, opened through a pharynx into the sac-shaped intestine. The tubular excretory bladder, anteriorly extending to some distance behind the rhynchus, opened through the excretory pore at the posterior end and, near the level of the pharynx, received the two transverse ducts formed by the anterior and posterior longitudinal collecting canals. The rudiments of the genitalia included the two rounded testes (situated symmetrically, in a line, or slightly obliquely behind the pharynx), the pretesticular ovary (lying just lateral to the pharynx or slightly posteriorly), the shell-gland mass (situated immediately posterior to the ovary), the developing uterus with its terminal part passing along the well-developed cirrus sac, and the common genital pore situated subterminally at the posterior end.

Measurements from the stained permanent mounts were: length 0.27–0.50 mm.; breadth 0.16–0.23 mm.; rhynchus 0.07–0.09 mm. in diameter; pharynx 0.04–0.06 mm. in diameter; testes of 0.02–0.027 mm., ovary 0.020–0.022 mm. and cirrus sac of 0.07–0.14  $\times$  0.02–0.03 mm. in

size. The specimens available from the different sites were within the size-range indicated.



FIGS. 1-3 (Camera lucida drawings). Fig. 1. A cyst. Figs. 2-3. Excysted juveniles. (Fig. 2. Living; Fig. 3. Stained mount.)

The collection from nearly 100 fingerlings of *A. morar* and *B. ovazardi*, available from the same pond, revealed an identical infection as judged from their topographical and dimensional characters. Evidently, the juveniles of two different classes of vertebrates harboured the same metacercaria. The present finding reports, for the first time, *Bucephalopsis metacercaria*, in the aquatic developmental stage of a toad. So far, small freshwater fishes are alone known to act as the second intermediate hosts of bucephalid gasterostomes. The available specimens, on grounds of topography, are assignable to *Bucephalopsis fusiformis*/*B. garuai*.

*Bucephalopsis*, with definitive hosts in the carnivorous siluroids, has a wide range of second intermediate hosts (Verma, 1936; Pande and Rai, 1964 and Rai, 1967). These, besides their own smaller specimens, include the juvenile stages of carps and a bufonid anuran

which seem to constitute the normal food of these fishes.

Thanks are due to the Director, Zoological Survey of India, Calcutta, for specific identification of the hosts and to the Principal of the College for the facilities provided.

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U.P. College of Vet. Sci. P. P. S. CHAUHAN.

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Mathura, October 18, 1967.

1. Chubrik, G. K., *Dokladi Akademii Nauk, S.S.S.R.*, 1952, **83**, 327.
2. Dollfus, R. P., *Bull. Lab. Arago. Univ.*, Paris, 1951, **2**, 350.
3. Pande, B. P. and Rai, P., *Curr. Sci.*, 1964, **33**, 685.
4. Rai, P., *Proc. Nat. Acad. Sci., India*, 1967 (in press).
5. Verma, C. C., *Ibid.*, 1936, **6**, 66.
6. Woodhead, A. E., *Trans. Amer. Micro. Soc.*, 1930, **49**, 1.

### INDUCTION OF POLYPLOIDY IN THE PASTURE LEGUME—*GLYCINE*\*

INDUCED polyploidy has played a considerable role in the evolution of superior strains of several forage species like Red clover (*Trifolium pratense* L.) and alsike clover (*T. hybridum* L.) in Scandinavian countries.<sup>1</sup> In India, Pusa Giant Berseem—the first colchicine-induced tetraploid—has been released recently for general cultivation.<sup>2</sup>

Investigations on the improvement of forage legume—*Glycine javanica*—through induced polyploidy were taken up in the Division of Botany, Indian Agricultural Research Institute, New Delhi-12, in 1964. The colchicine treatment was given in two batches, viz., (a) seed treatment and (b) seedling treatment. In the former case, seeds presoaked in water for 6 hours were treated with 0.025%, 0.05% and 0.1% colchicine solution for a period of 3, 6 and 9 hours and subsequently after washing, sown in pots. In the second method, the presoaked seeds were sown in pots and the apical buds of the young seedlings were treated with 0.1% and 0.2% colchicine solution for 3, 6 and 9 hours for one to three consecutive days by placing cottonwads saturated with colchicine in between the newly opened cotyledons. The technique which gave highest percentage of tetraploids was the apical bud treatment with cottonwads saturated with 0.2% colchicine solution for 6 hours for 2 days. The following is the summary of observations made on the induced raw tetraploids.

The autotetraploid plants show a bit slower growth at the initial stage but later on they

briskly catch up and produce greater number of branches and forage than the parental diploid. Further, the tetraploids showed increases in cell, stomata and pollen size and reduction in pollen and seed fertility. In addition, the induced polyploids had thicker, softer and more succulent stems, broader, thicker, darker green and more succulent leaves with lower leaflet index, larger floral parts and flowers and bigger seeds. The most distinguishing features of the tetraploids were (a) the tetraploids showed a tendency towards multifoliation and branches with tetra and pentfoliate leaves were met with as compared with trifoliate leaves invariably present in the diploids (Fig. 1 a, b), (b) they had bigger inflores-

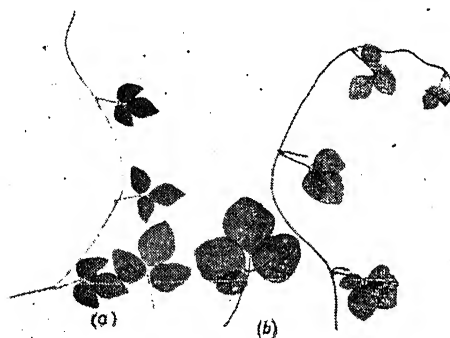


FIG. 1. (a) Twig and leaves of diploid plant. (b) Twig and leaves of induced tetraploid plant showing tetrafoliate leaves.

scences with larger number of floral whorls per inflorescence as also greater number of flower per whorl and (c) and fruiting pod size was significantly smaller and the number of seeds set per fruiting pod varied from 0 to 3 as against 5-6 seeds per pod in the diploids.

Central Sheep and Wool Research Institute,  
Malpura, Distt. Tonk,  
Rajasthan, October 24, 1967.

AMAR SINGH.

\* Contribution from Indian Agricultural Research Institute, New Delhi-12.

1. Akaberg, E., Binglefors, S., Josefsson, A. and Ellerston, S., "Induced polyploids in forage crops, Savalof, 1946-61," *Recent Plant Breeding Research*, Almqvist and Wiksell, Stockholm, 1963.
2. Mehta, R. K. and Swaminathan, M. S., "Pusa Giant Berseem—the first colchicine-induced tetraploid released for cultivation in India," *Ind. Fmg.*, 1965, 15 (6), 4.

## FOULING BRYOZOANS IN VISAKHAPATNAM HARBOUR

It is well known that marine ectoprocts, also known as polyzoa and bryozoa, contribute a good number of species to the fouling complex.<sup>3-6-9</sup> Both the erect and encrusting members form extensive colonies on ships' hulls, boats, wharves and other harbour installations. Previous workers<sup>1-2-7</sup> on marine fouling at Indian harbours paid scant attention to this important group and, except for the report of a few forms many of which were identified only upto genera, very little is known about their biology and ecology. In view of lack of this information, we have undertaken a detailed investigation of the fouling bryozoans of the Visakhapatnam harbour. This note is a preliminary account of the more common species collected from harbour structures and test plates submerged at four localities, Stations A, B and C (Ganapati *et al.*<sup>2</sup>) and Naval Base (N.B.). Nine species have been so far collected and identified. These are shown in Table I.

The reddish-purple and bushy tufts of the cosmopolitan species *B. neritina* are predominant at Stations A, B and N.B. from February to July. During this period, colonies of about 8 cm. height were usually collected from wooden jetties and barges. On glass plates the forms grow to a much smaller size. Ovicells were observed during March to June and this is the peak breeding period of this species in the local harbour. *B. stolonifera* is another important form which is found along with *B. neritina*. It could be distinguished from the latter by its greyish buff colour. This species was first recognized by Ryland<sup>8</sup> from Swansea, South Wales, and was subsequently recorded from Western Europe, Mediterranean, Adriatic<sup>9</sup> and Western Atlantic.<sup>5</sup> As far as we are aware, this is the first record of this species from the Indian Ocean. Our specimens (Fig. 1) agree well with the amended description of the species given by Maturo,<sup>5</sup> especially in the presence of avicularia of three different sizes, as mentioned by him. Its peak breeding period coincides with that of *B. neritina*. *Beania intermedia* was collected mainly on other erect colonies and occasionally from the jetties. They are, however, not very important from the fouling point of view because of their small size and delicate structure. The encrusting bryozoan *Electra bengalensis* is the most important and abundant form in the local harbour. At Stations A, B and N.B., the mat-like colonies are found throughout the year; but

TABLE I

Order Chelostomata	Family :	BUGULIDAE	1. <i>Bugula neritina</i> Linnaeus
	Family :	BEANIIDAE	2. <i>B. stolonifera</i> Ryland
	Family :	ELECTRINIDAE	3. <i>Beania intermedia</i> (Incks)
Order Ctenostomata	Family :	VESICULARIDAE	4. <i>Electra bengalensis</i> (Stoliczka)
	Family :	VICTORELLIDAE	5. <i>Zootryon verticillatum</i> (Delle Chiaje)
			6. <i>Bowerbankia gracilis</i> Leidy
			7. <i>Amathia distans</i> Busk
			8. <i>Victorella pavidata</i> Kent
			9. <i>Sundanella sibogae</i> (Harmer)

the peak period of its settlement is during the colder months November to January when the entire surface of the test plates are covered by thin flakes of these colonies. It is occasionally observed on fresh plates immersed at Station C. where, however, it did not survive and grow.

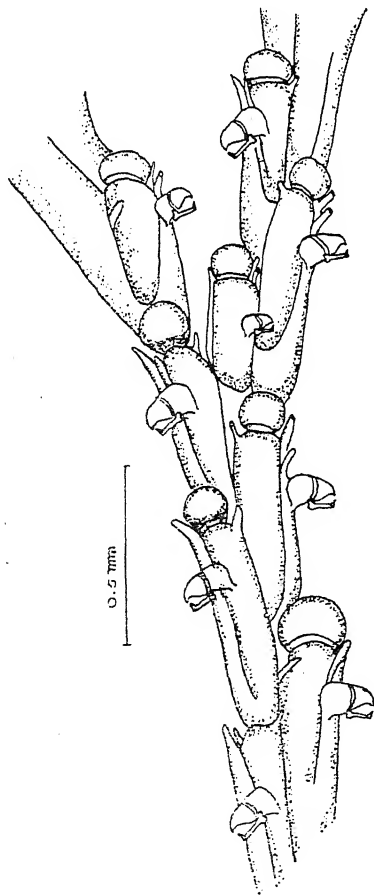


FIG. 1. *Bugula stolonifera* Ryland from Visakhapatnam harbour.

*Zootryon verticillatum* is the most dominant form during the summer months March-June. During this period the undersides of

wooden barges and boats support a luxuriant growth of the gelatinous and transparent strands of this fast-growing ctenostome which attains a length of about 60 cm. in two months. It is also common on concrete pillars but has not been collected from glass plates. After July there is a great diminution in the size of the colonies. *Amathia distans* attaches in abundance from March to June. The colonies are white or brownish in colour and are encountered at all stations except at C. The colonies of *Bowerbankia gracilis* occur mainly as creeping stolons which sometimes form dense clusters. They are present at all stations, but the zoecia studied from Stations C, have longer tails, a character based on which *B. caudata* Hincks was established. The latter is now considered to be a synonym of *B. gracilis*.<sup>4,9</sup> *Victorella pavidata* and *Sundanella sibogae* were collected on many occasions, the former from a barge at Station N.B. and the latter from the jetties at Station A.

The present investigation extends the number of fouling polyzoans at Visakhapatnam harbour from three to nine and highlights the importance of the group in this area. There is no doubt that more intensive collecting and careful examination of material may bring to light the existence of many more species. A perusal of the above account reveals two important points: (1) at Stations A, B and N.B. which are away from the source of pollution, the ectoprocts constitute an important element in the fouling assemblages whereas at Station C which is under the influence of pollution, only *B. gracilis* is present in small quantities; (2) the erect forms *B. neritina*, *B. stolonifera*, *Z. verticillatum*, *A. distans* settle in more numbers and grow profusely during the summer months March-June. In contrast, the encrusting species *E. bengalensis* is a very dominant fouler during the colder months November-January.

The authors are very grateful to Miss Patricia L. Cook of the British Museum (Natural History) for help in the identification of some of the species mentioned. The junior author

wishes to thank Sri. M. V. Lakshmana Rao for help during these studies. This work has been carried out with the funds provided by the Forest Research Institute and Colleges, Dehra Dun.

Dept. of Zoology, P. N. GANAPATI.  
Andhra University, K. SATYANARAYANA RAO.  
Waltair, November 23, 1967.

1. Daniel, A., *J. Madras Univ.*, 1954, **24 B** (2), 189.
2. Ganapati, P. N. *et al.*, *Andhra Univ.*, Ser. 62, *Mem. Oceanogr.*, 1958, **2**, 193.
3. Hutchins, L. W., In *Marine Fouling and its Prevention*, Woods Hole Oceanographic Institute, 1957, p. 165.
4. Maturro, F. J. S. Jr., *J. Elisha Mitchell Sci. Soc.*, 1952, **73** (1), 11.
5. —, *Bull. Mar. Sci.*, 1966, **16** (3), 556.
6. Nair, N. B., *Sarsia*, 1962, No. 8, p. 1.
7. Raja, B. T. A., *J. Mar. Biol. Assn. India*, 1959, **1** (2), 180.
8. Ryland, J. S., *Proc. Zool. Soc. London*, 1960, **134** (1), 65.
9. —, *Catalogue of Main Marine Fouling Organisms*, Polyzoa, 1965, **2**, 1.

# NUCLEAR DISTRIBUTION OF ACID PHOSPHATASE IN CAJANUS INDICUS SPRENG.

INTRACELLULAR distribution of acid phosphatase has been a question of great dispute. Its distribution has been reported in cytoplasm,<sup>1-4</sup> cytoplasmic particles,<sup>2</sup> mitochondria,<sup>2</sup> lysosomes,<sup>5</sup> cell wall, nucleus and nucleoli,<sup>6</sup> but its distribution in the nucleus has been seriously questioned.

In *Cajanus indicus* authors have studied the localization of acid phosphatase by Gomori's method.<sup>7</sup> For the study of acid phosphatase the seeds of *Cajanus indicus* were germinated on moist filterpapers in sterilized petridishes in an incubator at 30° C. When the length of the radicle was 1 cm. the longitudinal and transverse sections of the fresh tissue were cut to study the localization of the enzyme.

The substrate for enzymatic action was prepared by dissolving 0.6 gm. of lead nitrate in 500 ml. of 0.5 M sodium glycerophosphate. Every precaution was taken to avoid any precipitation during preparation of the solution. From this standard solution substrates of different pH were prepared, viz., 4.6, 4.8, 5.0, 5.2, 5.4, 5.6. The effect of temperature was also studied. The control consisted of (i) medium to which substrate (sodium glycerophosphate) was not added, (ii) usual substrate to which 0.1 M NaF was added, (iii) sections directly put in yellow ammonium sulfide, i.e., without

any treatment, (iv) the sections boiled in water and then treated as normal ones.

The sections were incubated in substrate for two hours at different temperatures. After incubation the sections were washed in distilled water and were kept in 2% acetic acid for one minute and then after washing with water the sections were transferred to a very dilute solution of yellow ammonium sulfide for three minutes. After washing the sections in water and dehydrating them in 90% alcohol and absolute alcohol they were finally counter-stained with crystal violet in clove oil and mounted in D.P.X. For identification of mitochondria and nucleus a few sections were stained with Janus Green B and acetocarmine respectively.

The sections in controlled conditions failed to indicate any activity. The optimum temperature for its activity was 37° C. at pH 5.0. The cytoplasm of the cells did not indicate any enzymatic activity as has been previously reported.<sup>1-5</sup> The entire acid phosphatase activity was found to be localized in the nucleus (Fig. 1). No trace of activity was

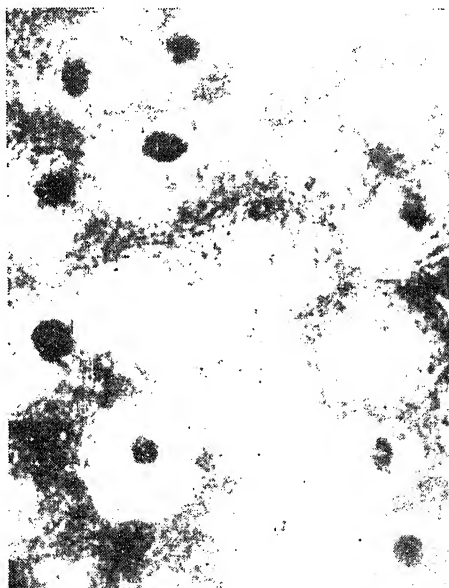


FIG. 1. Transverse section of the radicle of *Cajanus indicus*; nuclei showing intense acid phosphatase activity.

found in the cell wall. The present report is unique because the autonomus cytoplasmic inclusions, namely lysosomes and mitochondria, which were supposed to be the only centres of the activity of the enzyme did not indicate any activity. So the earlier reports<sup>6-8</sup> about its

distribution in nucleus and nucleoli appears to be more convincing for the cells of the radicle of the seedlings of *Cajanus indicus*.

Thanks are due to Prof. K. M. Gupta for providing necessary laboratory facilities.

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Jodhpur (India), September 1, 1967.

1. Dyar, M. T., *Am. J. Bot.*, 1950, **37**, 786.
2. Jensen, W. A., *Ibid.*, 1956, **43**, 50.
3. Avers, C. J. and King, E. E., *Ibid.*, 1960, **47**, 220.
4. Zalokar, M., *Exptl. Cell Res.*, 1960, **19**, 114.
5. Holt, S. J., *Exptl. Cell Res. Suppl.*, 1952, **7**, 1.
6. McGregor, S. M. and Street, H. E., *Ann. Botany*, 1953, **17**, 385.
7. Gomori, G., *Microscopic Histochemistry, Principles and Practice*, University of Chicago Press, Chicago, 1952.
8. Glick, D. and Fischer, E. E., *Arch. Biochem.*, 1946, **11**, 65.

### A NEW SPECIES OF *MYCOBLASTUS* FROM INDIA

THE lichen genus *Mycoblastus* Norm., comprising 19 species, distributed chiefly in the temperate parts of the world has not so far been reported from the Indian subcontinent. During the course of the collections of lichens from Darjeeling District, in the Eastern Himalaya, a *Mycoblastus* was found growing frequently on the bark of the trees at various localities between the altitudes of 1500–2000 m. The taxon was rather distinctive even in the field, and has later been found not to conform with the descriptions of any of the species known so far. It is therefore being proposed here as a new species.

*Mycoblastus indicum* AWASTHI et M. AGARWAL  
Sp. Nov.

**Diagnosis.**—Thallus epiphloëdes, crustaceous, expansus, usque ad 7 cm. latus, substrato adhærens, glauco-vel cinerescenti-albus, opacus, granulosis vel granuloso-verruculosus; sorediis et isidiis destitutis; K-, Cl-, Pd-. Apothecia numerosa, biatorina, sessilia, rotunda, 1.5–2 mm. lata, at basim leviter constricta, demum convexa; discus castaneus vel niger, planus, epruinosis; margo, integer, crassus, thallo concolor vel sordido-albus, demum margine valde tenuis. Hymenium 120–140  $\mu$  altum, I+ coerulescens; hypothecium crassiusculum, brunneo-nigrum, 220–280  $\mu$  altum. Asci clavati, 2–3 spori; sporæ uniseriatæ, simplices, decolores, ellipsoideæ, membrana 2–2.5  $\mu$  crassa, (28) 31–39 (43)  $\times$  12–18  $\mu$ ; paraphyses simplices, coherentæ,

apicibus parum crassioribus et obscuratis. Ad cortices.

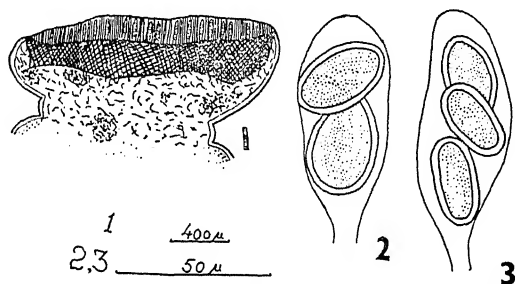
Thallus epiphloëdal, crustaceous, suborbicular, patches upto 7 cm. in diam., glaucous white to dark grey, usually no distinct margin, but in contact with other thalli, a poorly developed thin, fimbriate, brownish line present. Thallus in the peripheral area thin, smooth, ca. 65  $\mu$  thick, centrally granulose to granulose-verruculose, well-developed granules or verrucæ upto 300  $\mu$  wide and 220  $\mu$  thick; cortex of longitudinally disposed hyphæ, 25–30  $\mu$  thick, the exterior region obscure pale. Algal stratum irregular, occupying the greater part of the thallus below the cortex; algal cells green, 7–10  $\mu$  in diam., medullary hyphæ ca. 2  $\mu$  thick. Thallus K-, Cl-, Pd-.

Apothecia usually numerous, sessile, rounded to irregular in outline, 1.5–2 mm. in diam., biatorine; disc dark brown to black, plane to convex, occasionally reflexed; margin concolorous to thallus or darker, thick and entire in young stages, 90–105  $\mu$  thick, becoming thinner or partially excluded later. Proper exciple externally corticated by conglutinate hyphæ; cortex 25–31  $\mu$  thick; medullary region inside the cortex and below the hypothecium composed of short, thick, granulated hyphæ in amorphous groups (these give a false impression of algal cells in unstained preparations). Hymenium colourless, 117–140  $\mu$  thick, I+ blue; epihymenium yellowish-brown and amorphous; hypothecium dark brown to brown-black, 220–280  $\mu$  thick. Asci thin-walled, clavate, 78–93  $\times$  22–31  $\mu$ , 2–3 uniseriate spored (the 3-spored condition more frequent). Spores colourless, single-celled, oval ellipsoid, (28) 31–39 (43)  $\times$  12–18  $\mu$  in size, thick-walled, wall 2–2.5  $\mu$  thick; the spores when three in the ascus comparatively smaller in size than when two. Paraphyses simple, unbranched, coherent, apices yellowish, 1.5  $\mu$  thick. Usually the lowermost spore gets liberated first from the ascus when pressure is applied.

**Localities.**—India; Darjeeling District, Pashok Road, alt. ca. 2000 m., on bark of tree, coll. D. D. Awasthi and M. R. Agarwal, March 19, 1967, No. 67.78 (HOLOTYPE in LWU); Pashok Road, No. 67.89; Kurseong, Dow hill, alt. ca. 2000 m. coll. D. D. Awasthi and M. R. Agarwal, Nos. 66.224 and 66.237; Kalimpong Division, Munsong, alt. ca. 1500 m. coll. D. D. Awasthi and M. R. Agarwal, No. 67.328 (all specimens in LWU).

The new species *Mycoblastus indicum* is distinctive in the 2–3-spored condition of the

asci and the size of the spores. This is the only species recorded in which 3 spores have been seen in the ascus. The apothecia have a distinctive biatorine margin, though externally it appears concolorous to the thallus. The medulla of the exciple with its granulated hyphae shows similarity to *Mycoblastus endoxanthus* Groenh. and *M. griseomarginatus* Groenh. In general external appearance, the thallus shows resemblance to that of *Lecidea granifera* Vain.



FIGS. 1-3. Fig. 1, V.L.S. of apothecium, showing thick hypothecium, and granulated groups of hyphae below it. Figs. 2-3. Asci with 2 and 3 spored condition respectively.

The genus *Mycoblastus* was characterized and distinguished by the simple paraphyses, 1-2-spored asci, and simple, thick-walled, colourless spores by Zahlbruckner (1926). All the species except *M. griseomarginatus* (asci 8-spored, spores  $24-30 \times 15-18 \mu$ ), and *M. endoxanthus* (asci 4-6-spored, spores  $27-30 \times 15-20 \mu$ ), conform to the 1-2-spored condition of the ascus. With the addition of the species described now the spore condition in the ascus in the various species of the genus *Mycoblastus* ranges as 1, 2, 3, 4, 6, and 8, due to which an important distinction from *Lecidea*, which is characterized by 8-spored asci, has to be discounted. Thus, as was done by Groenhardt (1950), the thickened nature of the spore wall has to be taken for the distinction of the two genera, which for the present seems fairly satisfactory.

The present work has been carried out as part of the C.S.I.R. Research Project "Taxonomic Investigation on the Lichen Flora of India".

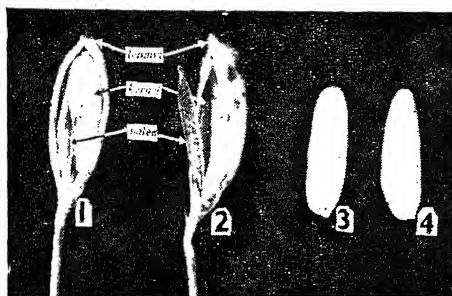
Department of Botany, D. D. AWASTHI.  
Lucknow University, M. R. AGARWAL.  
Lucknow, October 31, 1967.

1. Groenhardt, P., "Malaysian Lichens-II," *Reinwardtia*, 1950, 1, 36.
2. Zahlbruckner, A., "Flechten (Lichens) B. Spezieller Teil," In Engler and Prantl, *Die Natürlichen Pflanzenfamilien*, 2nd Ed., Leipzig, 1926, Band 8, p. 270.

## DEPRESSED PALEA IN RICE, *ORYZA SATIVA*, L.

In a cross between two clustered rice varieties (Ac. 1224-long glume  $\times$  7107-Jodon's gene marker), approximately one-fourth of the  $F_2$  plants had imperfectly-developed palea with varied expression. The length falls short of the lemma leaving an opening at the top; and the keel of the normally boat-shaped palea is flattened. This structure has been designated as 'depressed palea' (Figs. 1 and 2).

In the  $X_2$  population of an *indica* variety, a similar mutant has been recorded by Oka (1963) and its progeny, according to the author was highly sterile. In the present case also, the  $F_2$  individuals with this feature are highly sterile, but the fertility improves in subsequent generations. The development of the kernel is almost normal (Figs. 1 and 2) and due to looseness of the husk, the grain can be easily hulled. The genetics of this character is being further pursued.



FIGS. 1-4

Thanks are due to Dr. B. Misro, Geneticist and Botanist, for helpful suggestions.

Central Rice Res. Inst., R. THAKUR.  
Cuttack, December 5, 1967.

1. Oka, H. I., *Bot. Bull. Acad. Sinica*, 1963, 4, 47.

## ANEUPLOIDY IN GAMMA-IRRADIATED GRAM (*CICER ARIETINUM* L.)

DIFFERENT varieties of gram (*Cicer arietinum* L.) were irradiated with 15, 30, and 45 Kr. doses of gamma-rays in September 1965. The R2 generation of the treated varieties was raised in 1966-67 at the Botany Section, Agriculture College, Nagpur. These plants were studied for different morphological characters to find out the effects of irradiation.

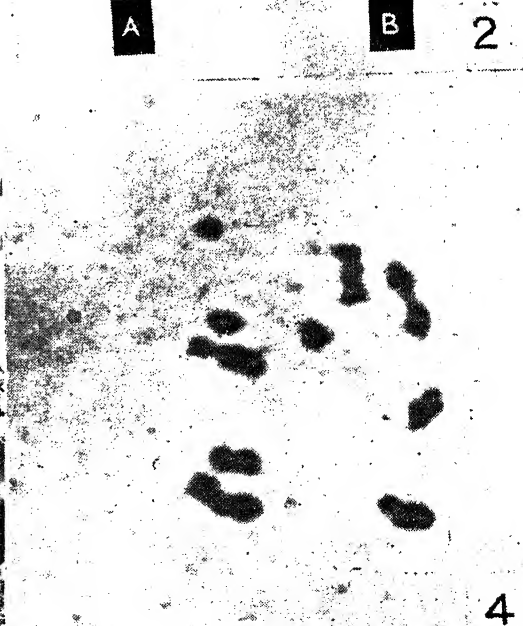
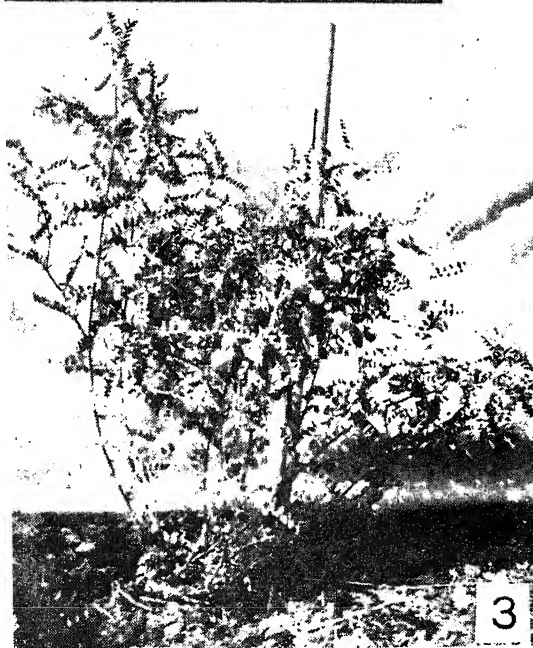
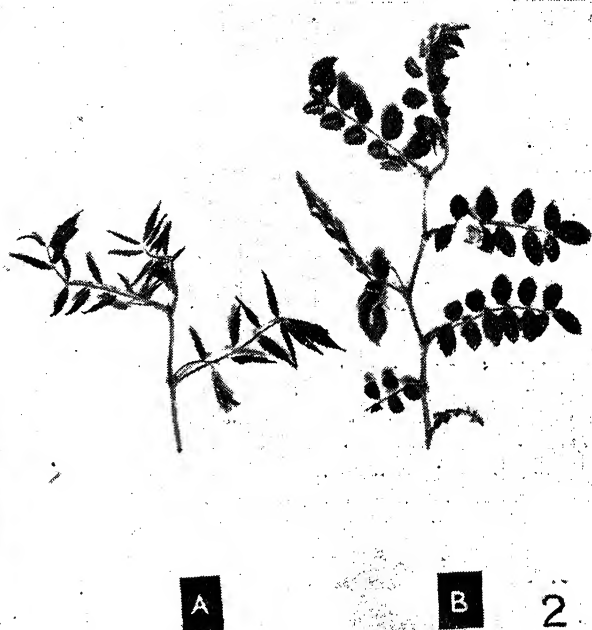
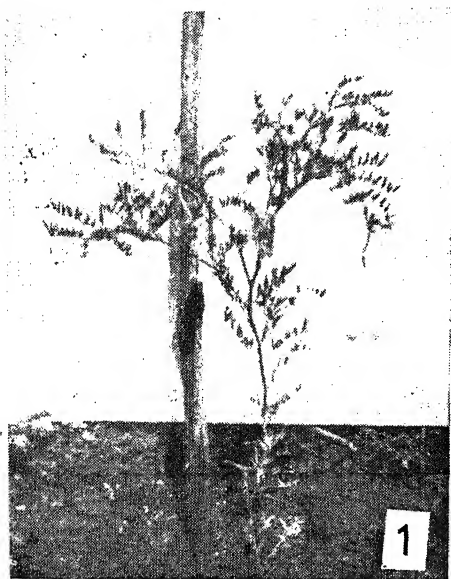
In 30 Kr. dose of a variety N. 59 a single plant was observed with distinct differences



in its morphological characters when compared to normal untreated plant. These differences can be summarised as follows:—

The plant was profusely branched and hairy. Its stem and branches were bent at each node giving a sort of zig-zag appearance (Figs. 1 and 3). Its average leaflet size was 10 mm.  $\times$

2 mm. as against 9 mm.  $\times$  4 mm. in the normal. These narrow leaflets made the plant extremely conspicuous (Fig. 2). Flowering commenced in this plant a week later than the average time required for flowering in the normal. It produced a few flowers with its standard modified into a horn-like structure. All the flowers



FIGS. 1-4. Fig. 1. Aneuploid gram plant ( $2n = 17$ ) in variety N-59. Fig. 2. Branches of (a) aneuploid, (b) normal plants. Fig. 3. Untreated gram plant of variety N-59. Fig. 4. Photomicrograph showing  $2n = 17$  chromosomes in the aneuploid,  $\times 1,250$ .



shedded soon after opening; probably shedding of flower took place before fertilization. Not a single pod could set on this plant. The pollen from the plant was transferred on the normal plant and its stigmas were also pollinated by the pollen of normal fertile plant for a number of times. These pollinations did not effect any setting indicating that the plant was both male and female sterile. The flower-buds from this plant were fixed in propione alcohol (3:1) and anthers examined cytologically in propione carmine. At metaphase I it showed  $2n = 17$  chromosomes (Fig. 4) as against  $2n = 16$  in normal plants. The examination of pollen grains in 1% IKI solution revealed these to be shrivelled and abnormal. The pollen did not germinate when grown on agar media, with different sugar concentrations.

Cytological studies made in PMCS from the few flower-buds available in this plant revealed a number of cases of abnormal meiotic divisions like multivalent formation and irregular distributions of chromosomes in I and II divisions. Athawal (1963) while describing effects of X-ray irradiation on gram (*C. arietinum*) reported the occurrence of sterile individuals in the  $\times 1$  and  $\times 2$  population. However, chromosomal variations were not reported by him in the treated material. Further studies on this irradiated population are in progress.

Botany Section, P. G. THOMBRE.  
College of Agriculture, M. V. THOMBRE.  
Nagpur, November 23, 1967. B. A. PHADNIS.

1. Athawal, D. S., *Indian Journal of Genetics and Plant Breeding*, 1963, 23 (1), 50.

#### FERTILITY OBSERVED IN SETAE OF *LACELLINOPSIS DESMOSTACHYAE*

DURING the investigation on "Succession of fungi on decaying leaves of *Saccharum munja* Roxb.", *Lacellinopsis desmostachyae* (Roy and Dwivedi), was collected on dead leaves of *Saccharum munja*. The remarkable features of this fungus are the production of conidia by setae at the tip after converting the latter into a vesicular structure. The pattern of formation of conidia on such setae is the same as in the case of normal conidiophores. Rarely there is branching of sterile setae. Further proliferation of a proliferated conidiophore into a tertiary conidiophore is observed. The characteristic features of the fungus are described below:

Setae simple, unbranched or rarely branched, long, dark brown at the base, becoming paler towards the tip. Sometimes setae proliferate

into sterile ones through cupulate apices or occasionally are converted into a conidiophore which bears conidia. Conidiophores with globose fertile tips. Conidia capitate, produced acropetally from globose tip of conidiophore, one-celled, globose, finely verrucose, pale brown to dark brown. Globose tip of conidiophore becoming cupulate after conidia are shed and then sometimes proliferating into sterile setae or into secondary and tertiary conidiophores.



FIGS. 1-3. Fig. 1. A seta and a conidiophore,  $\times 700$ . Fig. 2. Further proliferation of a secondary conidiophore into a tertiary conidiophore,  $\times 650$ . Fig. 3. A seta bearing conidia at the globose tip.  $\times 1,000$ .

Fertility observed in this fungus further supports the fertile nature of setae as observed earlier by Roy and Rai (1967 a, 1967 b) in case of *Lacellina fertilissima*, Roy and Rai, and *Colletotrichum capsici* (Syd.) Butler and Bisby.

Sincere thanks are due to Prof. R. Misra for the laboratory facilities. The junior author is thankful to C.S.I.R., Government of India, New Delhi, for a Senior Research Fellowship.

Dept. of Botany, R. Y. ROY.  
Banaras Hindu University, BHARAT RAI.  
Varanasi-5, December 5, 1967.

1. Roy, R. Y. and Rai, B., "New species of *Lacellina* and *Pithomyces*," An abstract in *Proc. 54th Indian Sci. Cong.*, 1967, Part III, p. 293 (Full paper accepted for publication in *Trans. Brit. Mycol. Soc.*).
2. — and —, "Fertility discovered in setae of *Lacellina* and *Colletotrichum*," *Prof. R. Misra Commemoration Vol.*, Botany Department, Banaras Hindu University, 1967, p. 21.
3. — and Dwivedi, R. S., "*Lacellinopsis desmostachyae* sp. nov.," *J. Indian bot. Soc.*, 1961, 40, 323.

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## REVIEWS AND NOTICES OF BOOKS

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**Mechanics of Materials.** By Alvin Sloane. (Dover Publications, Inc., New York), 1967. Pp. xvii + 468. Price \$ 2.75.

This is an unabridged and unaltered republication of first (1952) edition.

The book, which deals with behaviour of rods and beams under loads, is an introduction to theory of elasticity, designed for use in sophomore or junior level college courses in mechanical engineering. The mathematics employed is elementary, including only the simplest of calculus.

The chapters contained in this book are: Introduction to Mechanics of Materials; Bending. The Basic Flexure Theory; Corollary I—The Longitudinal Shear Theory; Corollary II—The Deflection Theory; Violations of the Limitations of the Flexure Theory; Torsion; Column Theory; Combined Loading; Elastic Strain Energy; Mechanical Properties of Materials; and Additional Uses of Mohr's Circle.

C. V. R.

**Atomic Physics (An Atomic Description of Physical Phenomena).** By Gaylord P. Harnwell and William E. Stephens. (Dover Publications, Inc., New York), 1966. Pp. xi + 401. Price \$ 2.50.

This Dover edition, first published in 1966, is an unabridged and corrected republication of the work originally published by McGraw-Hill Book Company, Inc., in 1955.

This edition also contains a new Preface by the authors.

Designed for students with some previous work in general and atomic physics, mechanics, and electricity and magnetism, the book's emphasis is upon the extension of the classical concepts of physics into the realms of atomic phenomena and upon the evolution of those quantum concepts which uniquely characterize the physics of elementary particles. Thus, it presents the experimental evidence which led to the adoption of new hypotheses and principles and it begins with a chapter on classical foundations.

The titles of the chapters are: Classical Foundations of Atomic Theory; Atomic Nature of Matter and Radiation; Atomic Structure; Electron Spin and Polyelectronic Atoms; Mole-

cular Structure; Statistics of Atomic Processes; and Elementary Properties of Matter.

C. V. R.

**Great Ideas in Information Theory, Language and Cybernetics.** By Jagjit Singh. (Dover Publications, Inc., New York), 1966. Pp. ix + 338. Price \$ 2.00.

Not only is the young, revolutionary science of cybernetics a fascinating study in itself, but it is also a frame of reference in which larger issues can be explored: the nature and genesis of human intelligence. In this Dover original, the author applies his skill as a science writer in an exploration of the computer and its ways, revealing the often striking resemblances between electronics and biological brains.

The contents are: Language and Communication; What is Information? Information Flow Over Discrete Channels; Coding Theory; Reliable Transmission and Redundancy; Continuous Channels; Information and Entropy; Automatic Computers—Analogue Machines; Automatic Computers—Digital Machines; The Computer and the Brain; Neural Networks—McCulloch and Pitts; Natural Networks—Von Neumann; Turing Machines; Intelligence Amplifiers; Learning Machines or Perceptrons; Artificial Intelligence—Game—Playing Machines; Artificial Intelligence—Translating Machines; Uttley Machines; and Mathematical Theories of the Living Brain.

C. V. R.

**Some Theory of Sampling.** By William Edwards Deming. (Dover Publications, Inc., New York), 1967. Pp. xix + 602. Price \$ 3.50.

Modern statistics, which has found its way into virtually every field, would be impossible without sampling techniques. The purpose of this book is to make such techniques understandable and useable, not only by statisticians and mathematicians, but also by social scientists, industrial managers, and natural scientists who find statistics increasingly important in their work and studies. Only college algebra is assumed.

The titles of the chapters contained in this book are: The Planning of Surveys; The Various Errors of Survey; Moments and Expected Values; Some Variances in Random

Sampling; Multistage Sampling, Ratio-Estimates, and Choice of Sampling Unit; Allocation in Stratified Sampling; Distinction Between Enumerative and Analytic Studies; Control of the Risks in Acceptance Sampling; The Sample as a Basis for Action; Estimation of the Precision of a Sample; Inventories by Sampling; A Population Sample for Greece; Detailed Study of Some Binomial and Related Distributions; The Gamma and Beta Functions; Distribution of the Variance in Samples from a Normal Universe; Tests for Hypotheses in Normal Theory; and The Distribution of the External and Internal Variances. C. V. R.

Russian-English Translators Dictionary (*A Guide to Scientific and Technical Usage*). By M. G. Zimmerman. (Plenum Press, 227, West 17th Street, New York, New York 10011, U.S.A.), 1967. Pp. 295. Price \$ 12.00.

A compendium of word combinations and expressions encountered in modern scientific and technical literature, based on the latest British and American sources for use by scientific and technical translators requiring the most up-to-date Russian idiomatic equivalents.

This collection of scientific expressions in context presents typical examples from various contemporary sources. Since the combined words given are usually common to a number of branches of science and technology, this dictionary is a particularly valuable guide to current usage in the specific discipline being translated. Arrangement is alphabetical and hyphenated combinations are considered as one word. Liberal cross-referencing greatly assists the user.

This book will be a valuable addition to the translator's shelf. C. V. R.

Statistical Physics : Berkeley Physics Course—(Vol. 5). By F. Reif. (McGraw-Hill Book Company). Pp. 398.

Some of the earlier volumes in this Berkeley Physics Course were reviewed in these columns [see *Curr. Sci.*, 1966, 35 (5), 133]. This last volume in the series is devoted to the study of macroscopic systems consisting of many atoms or molecules. Thus it provides an introduction to the subjects of statistical mechanics, kinetic theory, thermodynamics and heat. The subject-matter is covered in eight chapters under the following heads: 1. Characteristic Features of Macroscopic Systems; 2. Basic Probability Concepts; 3. Statistical Description of Systems

of Particles; 4. Thermal Interaction; 5. Microscopic Theory and Macroscopic Measurements; 6. Canonical Distribution in the Classical Approximation; 7. General Thermodynamic Interaction; and 8. Elementary Kinetic Theory of Transport Processes.

The treatment is lucid and coherent. Illustrations and get-up are excellent. The complete set of five volumes of this course provides foundation knowledge for a thorough understanding of modern physics with all its current developments. It is indispensable to university entrance and graduate course students in physics. A. S. G.

A First Course in Abstract Algebra. By J. B. Fraleigh. (Addison-Wesley Publishing Company, West End House, 11, Hills Place, London W. 1), 1967. Pp. 447. Price 53 sh.

The primary objective of this work is to provide a text from which an average student of mathematics can acquire as much depth and comprehension in his study of abstract algebra, exclusive of linear algebra, as is possible in a first course. The treatment is in two parts; the first part is concerned with groups leading to application of group theory to topology, and the second is devoted to ring theory, integral domains and unique factorization domains, and field theory up to and including Galois theory.

This basic introduction to modern algebra, with its large number of exercises and systematic treatment, should help a serious student to acquire the necessary fundamental knowledge and attitude to the study of the new discipline of abstract algebra. A. S. G.

Set Theory for the Mathematician. By Jean E. Rubin. (Holden-Day, Inc., 500, Sansome Street, San Francisco), 1967. Pp. 387. Price \$ 11.85.

This book is intended as a text in Set Theory for advanced undergraduate and graduate students in mathematics who are familiar with the language of mathematical abstractions. After an introductory chapter giving a brief historical background and a section on the mathematical logic, the fundamental concepts of set theory are developed under heads: Class Algebra, Functions and Relations, Natural Numbers, Finite and Infinite Classes, Ordering Relations, Ordinal Numbers, and Cardinal Numbers. There is also additional material suitable for specialized study under heads: The Rational and Real Numbers, Ordinal Number Theory,

Cardinal Numbers and the Axiom of Choice, The Generalized Continuum Hypothesis, Inaccessible Cardinals, and The Axiom of Constructibility.

A. S. G.

**An Introduction to the Alkaloids.** By G. A. Swan. (Blackwell Scientific Publications Limited, 5 Alfred Sreet, Oxford), 1967. Pp. 326. Price 63 sh.

Alkaloids are nitrogenous bases which occur naturally in plants. They contain their nitrogen as part of a heterocyclic system, and are often complex in structure. Apparently they are of no intrinsic value to the plants themselves and were once regarded as waste products of plant metabolism. The majority of alkaloids form colourless crystalline solids, and during recent years various physical methods such as spectroscopic, X-ray, n.m.r. and mass spectra have been successfully employed to elucidate their structures.

The alkaloids show specific pharmacological activity. The discovery of the clinical usefulness of the alkaloids of the *Rauwolfia* species gave impetus during the past fifteen years for an enlarged and concentrated attack upon the still unexplored botanical resources of the world. It is estimated that so far about two thousand alkaloids have been isolated and the structures of most of them are known.

The book under review provides an up-to-date introduction to alkaloid chemistry, and will be an ideal text-book on the subject for advanced undergraduates and for postgraduate students. The chief aim is the elucidation of the structures of some of the more important alkaloids. In pursuance of this object the alkaloids have been grouped according to their ring structures so as to illustrate a number of aspects of heterocyclic chemistry. A background knowledge of heterocyclic chemistry and structural determination is assumed. The pharmacological and biogenetic properties have also been briefly mentioned.

A. S. G.

**Advances in Agronomy** (Vol. 19). Edited by A. G. Norman. (Academic Press, Inc., Publishers, 111, Fifth Avenue, New York), 1967. Pp. 370. Price \$15.50.

As the previous volumes, the present volume also provides authoritative reviews of progress in crop and soil sciences and agronomic practice. The eight articles contained in this volume

are indicative of the diversity of research problems engaging the attention of workers in the field of agronomy.

It has been well established now that growth and grain yield are the end results of a series of biochemical reactions, each of which is controlled or catalyzed by one or more specific enzymes. The article by Hageman *et al.* focuses attention on the likely role of major metabolic enzymes and enzymic systems in the production of heterotic effects, and on possible utilization of such information in plant-breeding programs. In the article on Soil Phosphorus the author has emphasized the processes which control the level of useful phosphorus in the soil, and thus, in the final analysis, the productivity of the land. Cultivated *sorghum* has been a favourable species in which to study the inheritance of the two qualitative traits of height and maturity. The author of this article reviews the published information on maturity in *sorghum* and adds some new information on the subject.

The titles and authors of the articles are as follows: Mechanical Resistance as a Soil Factor Influencing the Growth of Roots and Underground Shoots, by K. P. Barley and E. L. Greacen; A Biochemical Approach to Corn-Breeding, by R. H. Hageman, E. R. Leng and J. W. Dudley; Preservation of Seed Stocks, by Edwin James; Silica in Soils, Plants, and Animals, by L. H. P. Jones and K. A. Handreck; Soil Phosphorus, by Sigurd Larsen; Growth and Mineral Nutrition of Tobacco, by C. B. McCants and W. G. Woltz; The Maturity Genes of *Sorghum*, by J. R. Quinby; and Soil and Fertilizer Requirements for Forests of *Pinus radiata*, by M. Raupach.

A. S. G.

#### Books Received

**Stationary Random Processes.** By YV. A. Rozanov. (Translated by A. Feinstein). (Holden-Day, Inc., 500, Sansome Street, San Francisco), 1967. Pp. 211. Price \$12.00.

**Scientific Principles and Moral Conduct.** By J. B. Conant. (Cambridge University Press, London N.W. 1), 1967. Pp. 47. Price 1 sh.

**Annual Reports in Medicinal Chemistry.** Edited by C. K. Cain. (Academic Press, New York), 1966. Pp. x + 368. Price \$7.95.

**Advances in Agronomy** (Vol. 19). Edited by A. G. Norman. (Academic Press, Inc., New York), 1967. Pp. xi + 370. Price \$15.50.

# CRYSTAL STRUCTURE OF 1-AMINO CYCLOPENTANE CARBOXYLIC ACID HYDROBROMIDE\*

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Centre of Advanced Study in Physics, University of Madras, Madras-25, India

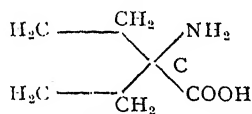
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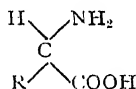
Biophysics Research Division, University of Michigan, Ann Arbor, U.S.A.

## 1. INTRODUCTION

**S**TRUCTURAL studies on amino acids and peptides occurring in proteins constitute a major part of the research work in this laboratory. The chemical formula of 1-amino cyclopentane carboxylic acid is



whereas, amino acids of proteins have the chemical formula



R being the side group. The latter have been well studied and the conformational aspects have been widely investigated. In view of the close similarity in the chemical formula between this compound and the amino acids occurring in proteins, the investigation of the crystal structure of 1-amino cyclopentane carboxylic acid hydrobromide has been undertaken by X-ray diffraction methods. The results are described below.

## 2. EXPERIMENTAL

The crystallographic data are:

Cell dimensions:  $a = 10.47$ ;  $b = 6.09$ ;

$c = 6.98 \text{ \AA}$  and  $\beta = 99.7^\circ$ ;

Space group:  $P2_1$

Contents of the unit cell:  $2(\text{C}_5\text{H}_{11}\text{NO}_2 \cdot \text{HBr})$

Calculated density:  $1.61 \text{ gm./c.c.}$

Observed density:  $1.615 \text{ gm./c.c.}$

Linear absorption coefficient  $\mu$  for  $\text{CuK}\alpha$   
 $= 64 \text{ cm.}^{-1}$

Three-dimensional X-ray intensity data were collected using the multiple film equi-inclination Weissenberg technique. 915 reflections were recorded with  $\text{CuK}\alpha$  radiation ( $\lambda = 1.542 \text{ \AA}$ ) for the layers  $hkl$  with  $k = 0$  through 5 about the needle axis- $b$ . The intensities were estimated visually by comparison with a graded set of intensities

recorded from the same crystal. These were corrected for the Lorentz and polarisation factors and placed on the absolute scale by layerwise Wilson plots. Absorption corrections were not applied.

## 3. DETERMINATION AND REFINEMENT OF THE STRUCTURE

The LP sharpened Patterson projection down the  $b$ -axis yielded the  $x$ - and  $z$ -co-ordinates of the bromine atom. Using bromine as the known part, a weighted beta synthesis<sup>1</sup> (Fig. 1)

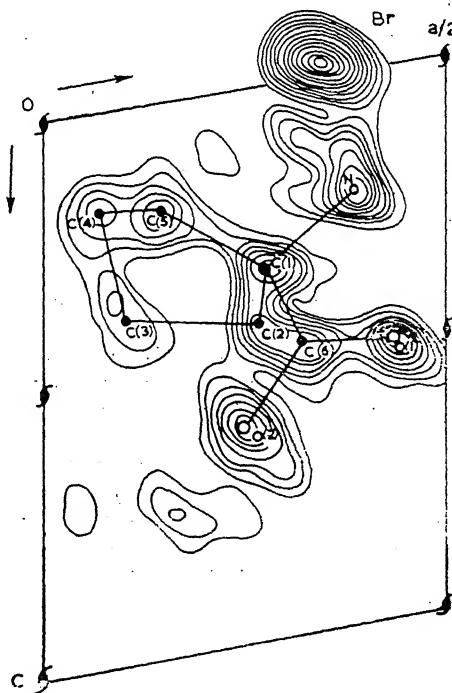


FIG. 1. Projection beta synthesis map down the  $b$ -axis. Contours from zero level at intervals of  $2e/\text{\AA}^2$  except near bromine where the interval is  $5e/\text{\AA}^2$ .

for this projection was computed. The structure could be easily fitted with the map and the  $R$ -index for the trial structure was 0.170 for the  $h0l$  reflections. Two cycles of difference-Fourier synthesis were carried out and the structure refined to  $R = 0.163$ . These maps

\* Contribution No. 230 from the Centre of Advanced Study in Physics, University of Madras, Madras-25.

indicated anisotropic thermal vibrations for the bromine atom.

A three-dimensional model of the structure was constructed from stereochemical considerations with the  $y$ -co-ordinate of the bromine atom at the origin. The  $y$ -co-ordinates of the rest of the atoms were taken from this model. The structure was then refined using the three-dimensional data by the method of least-squares. Two cycles of refinement were carried out on CDC 3600 with the program of Busing, Martin and Levy.<sup>2</sup> The positional and isotropic thermal parameters of all the atoms and the layerwise scale factors were varied in the refinement and the  $R$ -index dropped to 0.173 from the initial value of 0.210. It was then noticed that the atoms C(3) and C(4) were showing large thermal parameters ( $B \approx 9 \text{ \AA}^2$ ) while the rest were having much less values ( $B \approx 3.9 \text{ \AA}^2$ ). In addition the bond lengths C(2)—C(3) and C(3)—C(4) were not of standard value, the former being much longer (1.61 Å) and the latter being much shorter (1.39 Å).

At this stage a three-dimensional difference-Fourier synthesis was computed leaving these two atoms. The map showed significant anisotropic thermal vibration for the heavy atom bromine. Peaks had developed at the expected atomic sites of C(3) and C(4) with strengths of only  $1.8e/\text{\AA}^3$ . These peaks were extended along the  $y$ -direction over a spread of about 1 Å. Evidence for stereochemically feasible alternate sites for these atoms were not found in this map. Further refinement was now carried out using a suitable weighting scheme by minimising the function  $\sum W(|F_o| - |F_c|)^2$  where  $W$  is the weighting function adopted following Cruickshank *et al.*<sup>3</sup> Anisotropic thermal parameters were used for the heavy atom and three cycles of refinement using the full-matrix least-squares program of Gantzel, Sparks and Trueblood<sup>4</sup> brought down the  $R$ -index to 0.109.

#### 4. DISCUSSION OF THE STRUCTURE

The atomic parameters at the end of the refinement are given in Table I. The atoms C(3) and C(4) continue to have large thermal parameters. The bond lengths and bond angles in the molecule are shown in Fig. 2 and listed in Table II.

But for the short bond length C(4)—C(5) (1.44 Å), the other bond lengths and bond angles in the molecule agree well with the standard values. This anomaly in the bond length, together with the large  $B$  values for

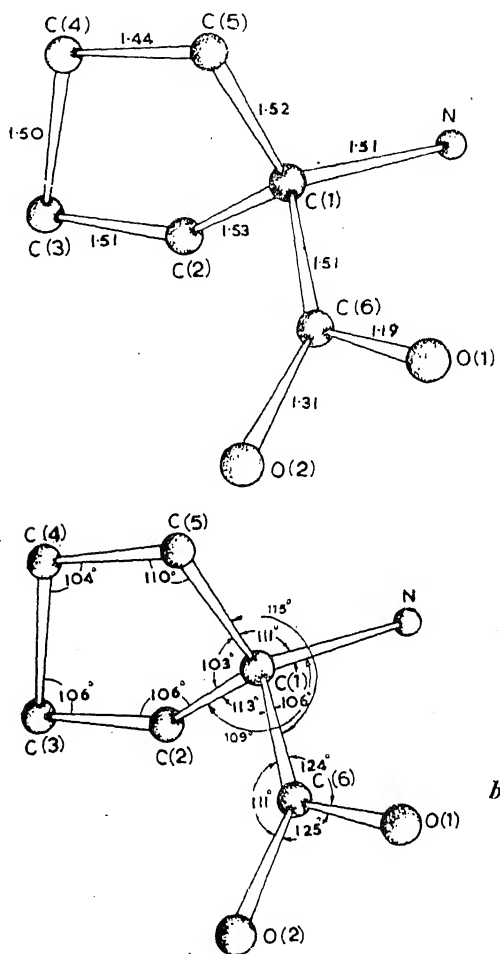


FIG. 2. (a) Bond lengths and (b) bond angles in the molecule.

TABLE I  
The final atomic co-ordinates (fractional)  
and thermal parameters

Atom	$x$	$y$	$z$	$B (\text{\AA}^2)$
Br	0.3444	0.0000	-0.0242	*
O (1)	0.4271	0.7628	0.5102	3.7
O (2)	0.2404	0.7026	0.6114	5.4
N	0.3810	0.4872	0.2166	3.2
C (1)	0.2771	0.5054	0.3410	3.1
C (2)	0.2555	0.2788	0.4254	4.5
C (3)	0.1129	0.2311	0.3713	9.0
C (4)	0.0669	0.3644	0.1917	9.0
C (5)	0.1472	0.5584	0.2179	4.1
C (6)	0.3249	0.6744	0.4954	2.9

$B_{11}$  0.0150  $B_{22}$  0.0198  $B_{33}$  0.0183  $B_{12}$  -0.0026  $B_{13}$  0.0143  $B_{23}$  -0.0112

The temperature factor is of the form

$$\exp \left[ - (B_{11} h^2 + B_{22} k^2 + B_{33} l^2 + B_{12} hk + B_{13} hl + B_{23} kl) \right]$$

TABLE II  
 Bond lengths and bond angles

Bond length (Å)	Bond angle (°)
C (6)-O (1) 1.19	O (1)-C (6)-O (2) 125
C (6)-O (2) 1.31	O (1)-C (6)-C (1) 124
C (6)-C (1) 1.51	O (2)-C (6)-C (1) 111
C (1)-N <sup>+</sup> 1.51	N-C (1)-C (2) 109
C (1)-C (2) 1.53	N-C (1)-C (5) 111
C (2)-C (3) 1.51	N-C (1)-C (6) 106
C (3)-C (4) 1.50	C (5)-C (1)-C (6) 115
C (4)-C (5) 1.44	C (2)-C (1)-C (6) 113
C (5)-C (1) 1.52	C (1)-C (2)-C (3) 106
	C (2)-C (3)-C (4) 106
	C (3)-C (4)-C (5) 104
	C (4)-C (5)-C (1) 110
	C (5)-C (1)-C (2) 103

the atoms C(3) and C(4) suggests the possibility of disorder existing in this part of the molecule. In connection with this, it may be mentioned that conformational energy calculations<sup>5,6</sup> for the cyclopentane ring have indicated that different conformers having the same minimum energy are possible. Further work taking into account these anomalies are in progress and will be reported elsewhere.

The two C—O distances of the carboxyl group are distinctly different and are in agreement with the values reported in structures where the carboxyl group exists as —COOH in the ionised form.

A view of the structure projected on (010) is shown in Fig. 3. There are four protons available for intermolecular hydrogen bonding and all of them take part in a three-dimensional network of hydrogen bonds. The hydrogen bond lengths and bond angles are given

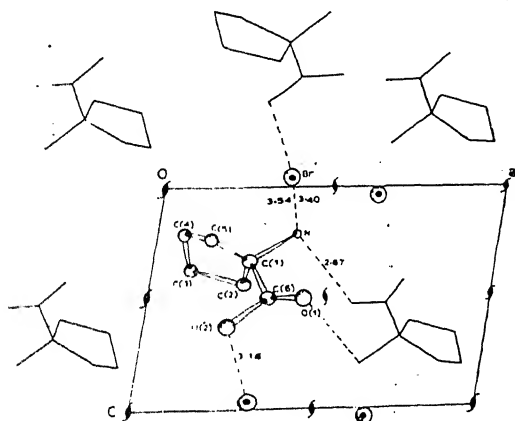


FIG. 3. View of the structure projected on (010).

 TABLE III  
 Hydrogen bond lengths and angles

CCU	Symmetry code	$x$	$y$	$z$
I		$x$	$1+y$	$z$
II		$x$	$1+y$	$1+z$
III		$1-x$	$\frac{1}{2}+y$	$-z$
IV		$1-x$	$y-\frac{1}{2}$	$1-z$
Bond length (Å)		Bond angle (°)		
O (2)-H...Br (II)	3.16	C (6)-O (2)...Br (II)	113	
N-H...Br	3.40	C (1)-N...Br	109	
N-H...O (1) (IV)	2.87	C (1)-N...O (1) (IV)	98	
N-H...Br (I)	3.54	C (1)-N...Br (I)	100	

in Table III. In the carboxyl group, O(2) is hydrogen-bonded to Br(II) and the distance O(2)-H...Br(II) is 3.16 Å. The hydrogen attached to the bromine atom has been transferred to the nitrogen forming a charged group —NH<sub>3</sub><sup>+</sup> and Br<sup>-</sup>. The nitrogen takes part in three hydrogen bonds of the types N-H...Br, N-H...O(1)(IV) and N-H...Br(I) of lengths 3.4, 2.87 and 3.54 Å respectively. In addition, there is a short ionic contact between the amino nitrogen and Br(III) of length 3.37 Å. Similar examples of four negatively charged atoms approaching a protonated amino group within hydrogen bond distances while only three of them are hydrogen-bonded are available in the literature.

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1. Ramachandran, G. N. and Ayyar, R. R., In *Crystallography and Crystal Perfection*, Ed. by G. N. Ramachandran, Academic Press, London, 1963, p. 25.
2. Busing, W. R., Martin, K. O. and Levy, W. A., *Oak Ridge National Laboratory Report ORNL-TM-305*, 1962.
3. Cruickshank, D. W. J., Pilling, D. E., Bujosa, A., Lovell, F. M. and Truter, M. R., In *Computing Methods and the Phase Problem*, Ed. by R. Pepinsky, J. M. Robertson and J. C. Speakman, Pergamon Press, London, 1961, p. 32.
4. Gantzel, P. K., Sparks, R. A. and Trueblood, K. N., *University of California Program, UCLALS 1*, 1961.
5. Pitzer, K. S. and Donath, W. E., *J. Am. Chem. Soc.*, 1959, **81**, 3213.
6. Hendrickson, J. B., *Ibid.*, 1961, **83**, 4537.

A STUDY OF THE CHEMICAL COMPONENTS OF *ENHYDRA FLUCTUANS*

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*ENHYDRA FLUCTUANS* is a marshy herb belonging to the family *Compositae* (tribe, *Heliantheae*) and has been used in Indian medicine in the treatment of skin diseases, nervous ailments and as a laxative.<sup>1</sup> Botanically and in its use it is closely allied to *Eclipta alba* which we have analysed recently in detail.<sup>2</sup> *Enhydra fluctuans* was examined earlier by Chakravarti and Dutta<sup>3</sup> who isolated stigmastanol. In our experiments we found that there is considerable variation from batch to batch of the plant material and it is not always available in the fresh condition. We now make a brief preliminary report of some special observations on the components of this plant.

From a petroleum ether extract of one of the batches collected in March, 1967, a very small yield of a lactone could be obtained merely on cooling the hot extract. It does not agree with any of the *Compositae* lactones reported so far and has therefore been named 'enhydrin'. As the amount available was small only a preliminary study, mainly spectral, has so far been possible. It crystallised from alcohol as colourless needles, m.p. 185-86°. The elemental analysis and molecular weight determination by mass spectrum (464) agreed with the molecular formula  $C_{23}H_{28}O_{10}$  and it contained one methoxyl group (Found:  $OCH_3$ , 6.0%;  $C_{22}H_{25}O_9$ ,  $OCH_3$  requires  $OCH_3$ , 6.7%). In its solubility and TLC behaviour and colour reaction with concentrated sulphuric acid (golden-yellow turning dark brown on gentle heating) enhydrin exhibited similarities with other sesquiterpene lactones of *Compositae* such as coronopilin,<sup>4</sup> ivaxillarin<sup>5</sup> (samples kindly supplied by Prof. W. Herz) and helenalin.<sup>6</sup> Its U.V. spectrum (in ethanol) had a strong end absorption in the region 220-240  $m\mu$  but no distinct maximum (cf. xanthinin<sup>7</sup>). The IR spectrum (nujol) had three frequencies in the carbonyl region at 1790, 1775 and 1730  $cm^{-1}$  (in KBr an inflexion at 1750  $cm^{-1}$  was also noticeable) which were suggestive of the presence of saturated  $\gamma$ -lactone as in psilostachyin,<sup>8</sup>  $\alpha$ - $\beta$  unsaturated- $\gamma$ -lactone and ester groups; the absorption at 1650  $cm^{-1}$  is attributable to an exocyclic double-bond conjugated with the  $\gamma$ -lactone, for which there is analogy in the observations of Herz and co-workers.<sup>5-10</sup> The weak, broad absorption at 3,650  $cm^{-1}$  could be

due to a hydroxyl which must be tertiary since enhydrin failed to undergo acetylation. The presence of the exocyclic double-bond was further supported by absorptions at 3,100 and 1,420  $cm^{-1}$  and confirmed by the characteristic pair of doublets (one proton each) at  $\delta$  5.79 and 6.32,  $J=3$  in the NMR spectrum (in benzene).

The NMR spectrum was run at 60 MC both in benzene and in chloroform but as the solubility of enhydrin in benzene was greater, the spectrum in that solvent was better resolved. Therefore the signal positions given in Table I are those observed in benzene solution; those of chloroform solution are given in brackets. The total proton count was 28.

TABLE I  
NMR spectrum of enhydrin

Signal position in ppm	No of protons	Assignment
1.05 (1.17)d ( $J=6$ )	3	A secondary methyl (E)
1.35 (1.45)	3	A tertiary methyl on a carbon carrying an oxygen function (G)
1.62 (1.72)	3	A tertiary methyl on a double bond (F)
1.67 (2.07)	3	Acetoxyl (D)
1.8-3.1 ( $\Delta$ group of complex signals)	7	..
3.57 (3.86)	3	Methoxyl or carbomethoxyl (C)
Ca 3.96	1	..
4.34 ct	1	Lactonic hydrogen (A)
5.79 d ( $J=3$ )	1	Exocyclic methylene conjugated with a lactone carbonyl (A)
6.32 d ( $J=3$ )	1	
5.92	1	..
6.17	1	May be a hydroxyl proton (signal position solvent dependent)

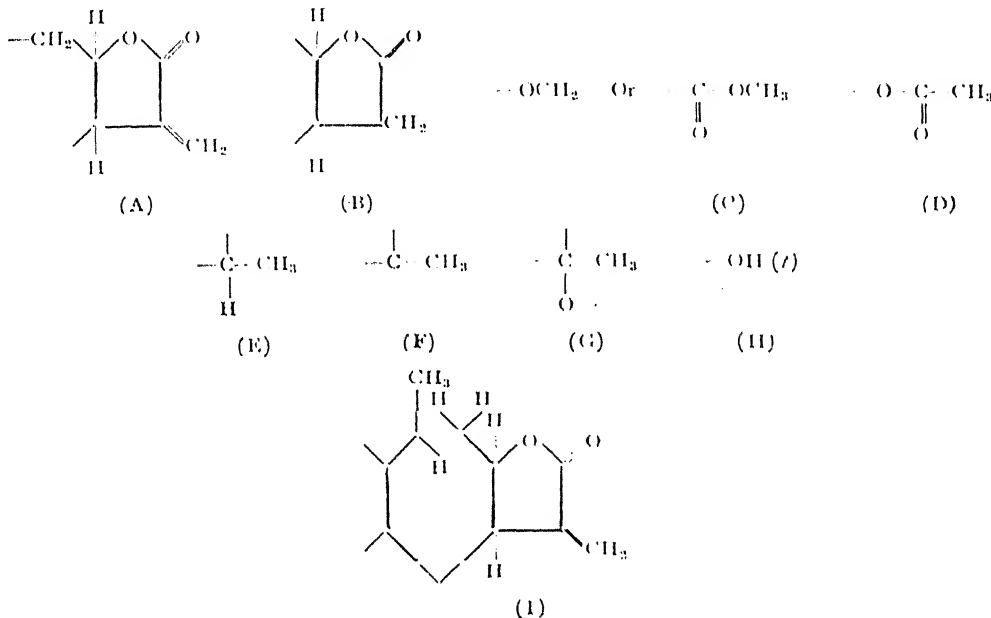
'd' denotes doublet; 'c' complex and 'ct' complex triplet.

The signals at 1.67(2.07) and 3.57(3.86) were markedly influenced by the nature of the solvent, benzene causing upfield shifts expected for the assignments given.<sup>9</sup> The characteristic complex triplet at 4.34 could be attributed either to the lactonic proton, i.e., the one adjacent to the oxygen of the unsaturated  $\gamma$ -lactone as in gaillardin,<sup>10</sup> calocephalin<sup>11</sup> and related compounds (part structure I) or to a proton in a similar environment. The former alternative is more likely since no signals



otherwise attributable to this lactonic proton could be detected. On the basis of these data the groups A to H are recognizable in enhydrin and the part structure (I) may be present in it also.

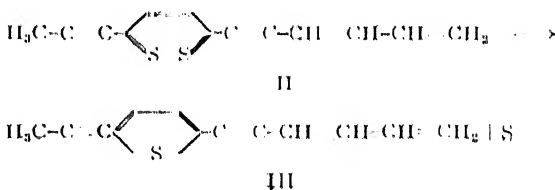
262-264 m $\mu$ . It was identified as elemental sulphur, the data agreeing with those for monoclinic. Obviously, it has been derived from a sulphur compound present in the plant. Bohlmann and Kleins<sup>12</sup> have recorded the isolation



A study of the mass spectrum supports some of the features mentioned above. Besides the molecular ion peak at m/e 464, some other prominent peaks appeared at m/e 446 (M-18), 433 (M-31), 405 (M-59) and 348 (M-116). The last-mentioned ion is the second most abundant, the base peak appearing at m/e 58. The M-18 peak supports the presence of a hydroxyl group and those at 433 and 405 support the carbomethoxyl. Further studies on the structure of enhydrin are in progress.

The petroleum ether extract, after removal of enhydrin, was further concentrated when a second solid separated. On TLC it gave a number of spots, two of which exhibited bright blue fluorescence under UV light. The brighter of these was eluted and a spectrum taken,  $\lambda_{\text{max}}^{\text{EtOH}}$  255, 350-355 m $\mu$ . The amount, however, was too little for further characterisation. The filtrate on concentration and chromatography over alumina yielded an orange-red petroleum ether eluate which gave a pale yellow crystalline solid and an orange-red oil. The solid answered the Lassaigne test for sulphur and crystallised from alcohol as pale yellow

plates and prisms, m.p. 118-20°;  $\lambda_{\text{max}}^{\text{cyclohexane}}$  of dark red oily compounds such as (II) accompanying the polyacetylenes and related thiophenes from extracts of some plants of *Heliantheae* and *Heleniae*. These compounds are unstable and decompose during chromatography or even in solution in course of time, yielding thiophenes such as (III) and elemental sulphur. It is probable that the sulphur of *E. fluctuans* might also have been derived from similar compounds. The accompanying orange-red oil mentioned above showed on TLC three spots exhibiting blue fluorescence under UV light much like the acetylenic thiophenes. Examination of the UV spectra of these components after TLC separation showed that they were similar to the spectra of acetylenic thiophenes though no definite identifications were possible.



A petroleum ether extract of another batch of the plant collected during the summer of 1967 did not yield enhydrin but gave elemental sulphur and the orange-red oil besides a good yield of a long chain aliphatic ester (m.p. 84-86°). A subsequent chloroform extract, did, however, contain enhydrin as shown by TLC but it could not be isolated in a pure state.

We thank Professor R. N. Chakravarti for the supply of the plant material from Calcutta, Professor W. Herz for the samples of coronopilin and ivaxillarlin and the Director, N.C.L., for the mass spectrum.

1. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, C.S.I.R. New Delhi, 1956, p. 107.

2. Krishnaswamy, N. R., Seshadri, T. R. and Sharma, B. R., *Tetrahedron Letters*, 1966, No. 35, 4227.
3. Chakravarti, R. N. and Dutta, A., *J. Ind. Chem. Soc.*, 1952, **29**, 3232.
4. Herz, W. and Hogenauer, G., *J. Org. Chem.*, 1961, **26**, 5011.
5. —, Sudarsanam, V. and Schmid, J. J., *Ibid.*, 1966, **31**, 3232.
6. Adams, R. and Herz, W., *J. Am. Chem. Soc.*, 1949, **71**, 2546.
7. Deuel, P. G. and Geissman, T. A., *Ibid.*, 1957, **79**, 3778.
8. Mabry, T. J., Miller, H. E., Kagan, H. B. and Renold, W., *Tetrahedron*, 1966, **22**, 1139.
9. Bhacca, N. S. and Williams, D. H., *Ibid.*, 1965, **21**, 2021.
10. Herz, W., Rajappa, S., Lakshmikantham, M. V. and Schmid, J. J., *Ibid.*, 1966, **22**, 693.
11. Batterham, T. J., Hart, N. K. and Lamberton, J. A., *Aust. J. Chem.*, 1966, **19**, 143.
12. Bohlmann, F. and Kleine, K. M., *Chem. Ber.*, 1965, **98**, 3081.

## RADIOCARBON DATES OF KALIBANGAN SAMPLES

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**K**ALIBANGAN, the well-known Harappan site on the river Ghaggar, has been extensively excavated (Ghosh, 1960-63) by B. B. Lal and B. K. Thapar under the aegis of the Archaeological Survey of India. The site was extensively sampled for both Kalibangan I and II periods. The  $C^{14}$  dates of the samples collected from this site and a brief discussion thereof are presented in this article.

All samples are cleaned manually first to get rid of extraneous matter including visible rootlets, and then treated with dilute HCl to remove soluble carbonates. Wherever possible, NaOH pretreatment was also given to remove any humic acid present. Samples are counted in the form of methane in gas proportional counters. For modern reference standard 95% activity of N.B.S. oxalic acid was used. Processing procedures have been described in detail earlier (Agrawal et al., 1965).

All dates are given in years B. P. The first date is based on radiocarbon half-life of 5568 yrs.; the second, within brackets, is based on the value of 5730 yrs.

### DISCUSSION

Kalibangan provided a very rich site for extensive sampling. A sizable number of samples was dated not only to determine the time-spreads of the two cultures, but also to study the internal consistency and factors

responsible for divergences, if any. As the excavations were scientifically controlled, any ambiguity due to stratification errors could largely be avoided. The only errors which could arise at this site were those due to humic acid and such other factors.

The Kalibangan Period I dates are all consistent, except for TF-240. Due to the presence of structures above, good levels with proper soil-cover generally could not be tapped for sampling the Period I sequence. Most of the samples are derived from the periphery of the mound. Thus humus contamination coupled with the inherent errors of the order of  $\pm 100$  yrs. can easily magnify such short-time brackets; the spread therefore could be smaller but in no case larger.

Kalibangan has by now been extensively dated (Agrawal and Kusumgar, 1966). For Kalibangan II (Harappan) a consistent sequence of dates exists for the early and middle phases. This helps in selecting the meaningful dates from the scatter of late phase.

We would discuss below the factors which could affect the dates at Kalibangan site.

The role of soil-cover in preserving the samples against contamination has been recognized. Sites that have been deserted thousands of years before, like Kalibangan, get humic acid from organic decay right up to the time

of excavations. Samples near this surface will get the maximum amount of youngest humic complexes. However, sites with continuous occupation up to the modern times will not be affected much as the difference in the humic acid activity and that of the sample from late historical levels will not be significant.

Two youngest dates were obtained for TF-138 and TF-244—both the samples were just near the surface. As these samples were fragile, NaOH pretreatment for the removal of humic acid too could not be given. Also, samples from the periphery of the mound (with nominal soil-cover), especially from KLB-1, did show some contamination. On the other hand, TF-607 and TF-608, which were collected purposely from under a deep soil-cover ( $\sim 4.5$  m.), gave the earliest dates for early Harappan phase at Kalibangan. On the whole,  $C^{14}$  dates for Kalibangan Period I and the early and middle phases of Period II are internally consistent; only late phase of Period II shows scatter.

Faulting of strata does allow upper material to percolate to the lower levels. Clear evidence of subsidence was reported by the excavator in the sections above the levels from which TF-162 and TF-240 derived. Both of these samples show younger than archaeologically expected ages.

While "humic" contamination tends to make the dates younger, "post-sample-growth error", on the other hand, makes them older. For example, if a tree of 200 years age is felled and charcoal from its periphery and core dated separately—the two samples should show a difference of 200 years though derived from the same tree. Slightly older dates for TF-25 and TF-153 from Kalibangan may be due to post-sample-growth error. For example, samples from Karla (TF-185, TF-171 and BM-92) which were derived from the core portions of big trunks all gave older ages.

Our conclusions from these studies are that charred grain and charcoal from short-lived trees, from strata preserved by sufficient soil-cover, make ideal samples for  $C^{14}$  dating.

#### ACKNOWLEDGEMENTS

We are beholden to Prof. D. Lal for guidance. Shri B. K. Thapar very enthusiastically discussed with the authors about individual samples and their location. The present work would not have been possible but for the zealous co-operation of the excavators, Sarvashri B. B.

Lal and B. K. Thapar, to whom our thanks are due.

#### $C^{14}$ DATES WITH SAMPLE DESCRIPTIONS

##### *Kalibangan, Rajasthan, India*

Kalibangan (Lat.  $29^{\circ} 25' N.$ , Long.  $74^{\circ} 05' E.$ ), District Sri Ganganagar, is a well-known Harappan site. The site was identified by A. Ghosh and is being excavated by B. B. Lal and B. K. Thapar since 1961.

There are two cultural periods at the site. The excavators prefer to call them Kalibangan I\*, the earlier period and, Kalibangan II\*, the Harappan period. The same terminology has been used in this paper.

TF-138, Kalibangan II,  $3075 \pm 100$   
( $3165 \pm 105$ )

Charcoal from Trench KLB-2, Locus A 7, Qdt. 4, Layer 3, Depth 0.9 m., Field No. KLB-2, A7/C/1962-63-1. Comment: sample derives from the uppermost levels of the mound. Deposit covered by a thin Layer (2) on the slope. Late phase.

TF-244, Kalibangan II,  $3250 \pm 90$   
( $3340 \pm 95$ )

Charcoal from Trench KLB-2, Locus E 2, Qdt. 4, Layer 2, Depth 0.35 m., Field No. KLB-2, E2/C/1963-64-4. Comment: sample derives from the uppermost levels of the mound. Covered by Layer (1) 15 cm. thick. Late phase.

TF-143, Kalibangan II,  $3510 \pm 110$   
( $3615 \pm 110$ )

Wood from Trench KLB-2, Locus YA 1, Qdt. 3, Layer 2, Depth 0.25 m., Field No. KLB-2, YA 1/C/1962-63-8. Covered by 10 cm. deposit of Layer (1). Late phase.

TF-149, Kalibangan II,  $3675 \pm 140$   
( $3780 \pm 145$ )

Charcoal from Trench KLB-2, Locus ZE 1, Qdt. 4, Layer 3, Depth 0.65 m., Field No. KLB-2, ZE 1/C/1962-63-15. NaOH pretreatment was also given. Comment: late phase.

TF-153, Kalibangan II,  $3910 \pm 110$   
( $4025 \pm 110$ )

Charcoal from Trench KLB-2, Locus XB 7, Qdt. 2, Hearth sealed by layer 1, Depth 0.25 m.,

\* These periods should be distinguished from the identical names of the two mounds of Kalibangan.

Field No. KLB-2, XB 7/C/1962-63-20. Comment: late phase (?). Older date may be due to post-sample growth error.

TF-152, Kalibangan II,  $3615 \pm 85$   
( $3720 \pm 90$ )

Charcoal from Trench KLB-2, Locus XB 9, Qdt. 4, Layer 5, Depth 0.95 m., Field No. KLB-2, XB 9/C/1962-63-18. NaOH pretreatment was also given. Comment: soil-cover about 80 cm. Middle phase.

TF-142, Kalibangan II,  $3635 \pm 100$   
( $3740 \pm 105$ )

Charcoal from Trench KLB-2, Locus XB 8, Qdt. 4, Layer 4, Depth 1.15 m., Field No. KLB-2, XB 8/C/1962-63-7. Comment: middle phase.

TF-141, Kalibangan II,  $3705 \pm 110$   
( $3810 \pm 115$ )

Charcoal from Trench KLB-2, Locus A 7, Qdt. 3, Layer 7, Depth 1.64 m., Field No. KLB-2, A 7/C/1962-63-6. Comment: middle phase.

TF-163, Kalibangan II,  $3910 \pm 100$   
( $4030 \pm 105$ )

Charcoal from Trench KLB-1, Locus YE 1, Qdt. 4, Layer 2 R, Depth 0.47 m., Field No. KLB-1, YE 1/C/1962-63-13. Comment: early phase.

TF-607, Kalibangan II,  $3930 \pm 120$   
( $4040 \pm 125$ )

Charred wheat and charcoal bits from Trench KLB-2, Locus A-8, Qdt. 2, Layer 18. Depth 4.10 m., Field No. KLB-2, A-8/C/1965-66-9. Comment: early phase.

TF-608, Kalibangan II,  $3910 \pm 110$   
( $4025 \pm 110$ )

Charred wheat from Trench KLB-2, Locus A-6, Qdt. 2, Layer 18, Depth 4.50 m., Field No. KLB-2, A-6/C/1965-66-10. Comment: early phase.

TF-605, Citadel Fortification,  $3810 \pm 105$   
( $3925 \pm 110$ )

Charcoal from Trench KLB-1, Locus ZB-9, Qdt. 3, Layer 10, Depth 1.65 m., Field No. KLB-1, ZB-9/C/1965-66-7. NaOH pretreatment was also given. Comment: seems to be well covered. Sample belongs to late phase of citadel fortification.

TF-154, Kalibangan I,  $3665 \pm 110$   
( $3770 \pm 115$ )

Charcoal from Trench KLB-1, Locus ZC 2: Layer 8, Depth 2.7 m., Field No. KLB-1, ZC 2/C/1962-63-2. Comment: late phase.

TF-165, Kalibangan I,  $3800 \pm 100$   
( $3915 \pm 105$ )

Charcoal from Trench KLB-1, Locus XD-1, Qdt. 1 and 2, Layer 2 R, Depth 2.35 m., Field No. KLB-1, XD 1/C/1962-63-15. Comment: late phase.

TF-156, Kalibangan I,  $3740 \pm 105$   
( $3850 \pm 110$ )

Charcoal from Trench KLB-1, Locus XE 1, Qdt. 1, Layer 2, Depth 0.8 m., Field No. KLB-1, XE 1/C/1962-63-5. NaOH pretreatment was also given.

TF-161, Kalibangan I,  $3930 \pm 100$   
( $4045 \pm 105$ )

Charcoal from Trench KLB-1, Locus YF 2, Qdt. 2, Layer 3, Depth 1.4 m., Field No. KLB-1, YF 2/C/1962-63-11. Comment: middle phase.

TF-162, Kalibangan I,  $3940 \pm 100$   
( $4055 \pm 105$ )

Charcoal from Trench KLB-1, Locus XE 1, Qdt. 2, Pit 1 sealed by Layer 3, Depth 1.85 m., Field No. KLB-1, XE 1/C/1962-63-12. Comment: early phase. Substantial subsidence in the section evident (B.K.T.).

TF-241, Kalibangan I,  $4090 \pm 90$   
( $4205 \pm 95$ )

Charcoal from Trench KLB-1, Locus XD 1, Qdt. 1, Pit 4 sealed by Layer 2, Depth 2.75 m., Field No. KLB-1, XD 1/C/1963-64-1. Comment: early phase.

TF-157, Kalibangan I,  $4120 \pm 110$   
( $4240 \pm 120$ )

Charcoal from Trench KLB-1, Locus YF 2, Qdt. 3, Layer 5, Depth 1.2 m., Field No. KLB-1, YF 2/C/1962-63-7. Comment: early phase.

TF-155, Kalibangan I,  $4195 \pm 115$   
( $4320 \pm 120$ )

Charcoal from Trench KLB-1, Locus ZB 2, Layer 9 B, Depth 3.40 m., Field No. KLB-1, ZB 2/C/1962-63-3. Comment: sample from just above the natural soil; 3.3 m., soil-cover. Early phase.

TF-240, Kalibangan I,  $3610 \pm 110$   
( $3715 \pm 115$ )

Charcoal from Trench KLB-1, Locus XD 1, Qd. 1, Pit 3 sealed by Layer 3, Depth 2.50 m., Field No. KLB-1, XD 1/C/1963-64-1. NaOH pretreatment was also given. Comment: date is younger than expected archaeologically.

1. Agrawal, D. P., and Kusumgar, Sheela, *Radiocarbon*, 1966, 8, 442.
2. —, and Lal, D., *Curr. Sci.*, 1965, 34 (13), 394.
3. Ghosh, A., *Indian Archaeology—A Review*, 1960-63.

## MOULDS AND MEN

“**M**OULDs and men are going to proceed till the end of time very much in each other's company.” Moulds, the tiny and often microscopic fungi which will grow on almost anything, are, ironically, best known to the public through their ability to produce chemical weapons, such as antibiotics, so valuable in the fight against disease. These drugs have given moulds the reputation of being the friends of man, but in fact they are just about the toughest and most adaptable parasites that human beings have to cope with.

Moulds are more truly parasitic than most of the plants called parasites, because they contain no chlorophyll. They are unable to trap the Sun's energy and use it to convert water and carbon dioxide into more complex compounds. Instead, they obtain the ready-made chemical building-blocks from somewhere else, by using a method of feeding known as saprophytic. This is done with a network of tiny white threads called a *mycelium*. These threads can be found on jam, bread or old golf shoes. The threads, properly called *hyphae*, absorb food continually all over their surfaces, but unfortunately such familiar foods are only a tiny fraction of the substances which fungi have learnt to dissolve and absorb in their continual hunt for food. The latest problem brought about by ravening fungi is the damage they cause to electronic equipment.

Modern circuits are often miniaturised to the point where the components are so closely

packed that they cannot be cleaned. The connections between them are usually made from wires covered with polyvinyl chloride plastic, or with cotton, both of which are food to fungi. Not only do moulds destroy insulation and cause short-circuiting in this way, they also form their network of mycelium inside black boxes full of electronic equipment and these threads conduct electricity enough to spoil the working of delicate equipment.

Moulds have also been making a special nuisance of themselves in optical instruments. They feed on the leather cases of such instruments and spread to the lubricating greases and sealing compounds used to keep other forms of life out. They also eat the surface lacquer finishes of the glass. They corrode metal parts and even etch away the glass itself. Fungi in the tropics are now seriously delaying the progress of medical research by their attacks on all kinds of instruments, including microscopes.

What is the answer to this growing problem of the ubiquitous mould? One suggestion which has been tried is to use high doses of radiation for fungal control. But the moulds which are now learning to attack most of the new plastics as easily as dry rot attacks wood pose a problem, because radiation powerful enough to kill them is also liable to alter the chemical properties of the plastics.—(Courtesy: British Information Service, British High Commission in India.)

## LETTERS TO THE EDITOR

VIBRATIONAL SPECTRA OF *o*-, *m*- AND *p*-METHOXYBENZALDEHYDES

The spectroscopic studies of the three isomeric methoxybenzaldehydes have been done by various workers.<sup>1-8</sup>

The infrared absorption spectrum of *o*-methoxybenzaldehyde was recorded on a Perkin-Elmer-521 infrared grating spectrophotometer in the region 250-4,000  $\text{cm}^{-1}$ . The infrared spectra of *m*- and *p*-methoxybenzaldehydes were recorded on a double beam Carl Zeiss UR-10 spectrophotometer in the region 400-700  $\text{cm}^{-1}$  and on a Hilger H-800 spectrophotometer in the region 700-4,000  $\text{cm}^{-1}$  in the liquid phase.

The *p*-methoxybenzaldehyde molecule in which  $\text{OCH}_3$  and CHO groups lie at 1 and 4

positions of the benzene ring, belongs to  $C_2$  point group to a first approximation. Out of 48 vibrations, 30 are benzene-like and consist of  $11a_1$ ,  $10b_1$ ,  $3a_2$  and  $6b_2$  types and are all allowed in the Raman spectrum, and all but  $a_2$  in the infrared spectrum. The *o*- and *m*-methoxybenzaldehyde molecules belong to  $C_s$  point group with the plane of the ring as the only element of symmetry and the 30 benzene-like vibrations are classified into  $21a'$  planar and  $9a''$  non-planar vibrations. The wave number, relative intensity and assignments of the fundamental frequencies of the isomeric methoxybenzaldehydes are given in Table I. In making the assignments guidance

TABLE I  
Correlation of the vibrational frequencies of *o*-, *m*- and *p*-methoxybenzaldehydes

Ortho $\text{cm}^{-1}$	Meta $\text{cm}^{-1}$	Para $\text{cm}^{-1}$	Assignment
3069 ( $7\frac{1}{2}$ )	3068 (2)	3059 ( $4\frac{1}{2}$ )	C—H stretching
	3024* (2)		"
3001 (8)	3006 ( $2\frac{1}{2}$ )		"
2960 ( $8\frac{1}{2}$ )	2962 ( $3\frac{1}{2}$ )	2949 (7)	C—H asymmetric stretching in $\text{CH}_3$ group
2937 (9)	2945 ( $8\frac{1}{2}$ )		"
2837 ( $9\frac{1}{2}$ )	2827 (8)	2829 (8)	C—H symmetric stretching in $\text{CH}_3$ group
2753 (7)	2728 ( $7\frac{1}{2}$ )	2736 (7)	C—H stretching in CHO group
1684 (9)	1704 (10)	1698 ( $9\frac{1}{2}$ )	C=O stretching
1588 (10)	1589 (10)	1596 ( $9\frac{1}{2}$ )	C=C stretching
1555 ( $5\frac{1}{2}$ )	1542 ( $1\frac{1}{2}$ )	1584 (10)	"
1482 (10)	1487 ( $9\frac{1}{2}$ )	1478 ( $8\frac{1}{2}$ )	"
1460 (10)	1462 ( $9\frac{1}{2}$ )	1439 ( $7\frac{1}{2}$ )	C—H asymmetric bending $\text{CH}_3$ group
1435 (10)	1435 (9)	1424 ( $8\frac{1}{2}$ )	"
1392 (10)	1392 ( $8\frac{1}{2}$ )	1392 ( $6\frac{1}{2}$ )	C=C stretching
	1386 (8)	1359 ( $3\frac{1}{2}$ )	C—H symmetric bending $\text{CH}_3$ group
	1323 (9)	1306 (9)	C—H in-plane bending in the CHO group
1286 (10)	1289 (10)	1285 ( $9\frac{1}{2}$ )	C—H in-plane bending
1242 (10)	1268 (10)	1255 (10)	C—OCH <sub>3</sub> stretching
1185 (10)	1193 ( $7\frac{1}{2}$ )	1216 (10)	C—H in-plane bending
1163 (10)	1167 (9)	1180 ( $8\frac{1}{2}$ )	"
1156 (10)	1150 ( $9\frac{1}{2}$ )	1159 (10)	"
1100 (10)	1081 (4)	1058 (1)	$\text{CH}_3$ rocking
1040 (10)	991 (5)	1024 ( $9\frac{1}{2}$ )	C—C stretching ring breathing
1018 (10)	1007 (3)		C—C—C in-plane bending
946 (5)	955 ( $1\frac{1}{2}$ )	959 ( $\frac{1}{2}$ )	C—H out-of-plane bending
	930 ( $6\frac{1}{2}$ )	941 ( $\frac{1}{2}$ )	"
855 (7)	901 ( $6\frac{1}{2}$ )	850 ( $8\frac{1}{2}$ )	"
830 (10)	866 (6)	833 ( $9\frac{1}{2}$ )	C—CHO stretching
758 (10)	789 (9)	764 (4)	C—H out-of-plane bending
781 (9)	794 (9)	816 ( $7\frac{1}{2}$ )	O—CH <sub>3</sub> stretching
684 (1)	683 (6)	704 ( $\frac{1}{2}$ )	C—C—C out-of-plane bending
644 ( $9\frac{1}{2}$ )	646 ( $3\frac{1}{2}$ )	642 ( $2\frac{1}{2}$ )	C—C—C in-plane bending
575 ( $6\frac{1}{2}$ )	552 (2)		C—OCH <sub>3</sub> in-plane bending
525 ( $4\frac{1}{2}$ )		514 ( $2\frac{1}{2}$ )	O—CH <sub>3</sub> in-plane bending
472 ( $9\frac{1}{2}$ )			C—C—C in-plane bending
432 ( $6\frac{1}{2}$ )			C—CHO in-plane bending
402* ( $3\delta$ )	439 (3)	384* (1)	C—C—C out-of-plane bending
270* ( $\frac{1}{2}\delta$ )		275* ( $2\delta$ )	"
195* (1)	165* (1)	191* ( $3\delta$ )	C—OCH <sub>3</sub> out-of-plane bending
124* (1)	132* (2)		C—CHO twisting

\* These values have been taken from the Raman data.  $\delta$ =broad.

has been taken from the assignments proposed for some of the related compounds.<sup>9-10</sup>

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Dept. of Spectroscopy, M. P. SRIVASTAVA.  
Banaras Hindu University, O. N. SINGH.  
Varanasi-5, I. S. SINGH.  
October 30, 1967.

1. Purvis, J. E., *J. Chem. Soc.*, 1914, p. 2482.
2. Morton, R. A. and Stubbs, A. L., *Ibid.*, 1940; p. 1347.
3. Jaiswal, R. M. P., *Ind. J. Pure Appl. Phys.*, 1965, 3, 405.
4. Dwivedi, C. P. D., *Ibid.*, 1965, 3, 452.
5. Kahovec, L. and Kohlrausch, K. W. F., *Z. Phys. Chem.*, 1937, 38 B, 119.
6. Marisa Scrocco and Arnaldo Liberti, *Ricerca Sci.*, 1954, 24, 1687.
7. Dietrich Heinert and Arthur E. Martell, *J. Am. Chem. Soc.*, 1959, 81, 3933.
8. Sharga Pinchas, *Anal. Chem.*, 1955, 27, 2.
9. Padhye, M. R. and Viladkar, B. G., *J. Sci. and Ind. Res.*, 1960, 19 B, 45.
10. Singh, V. B. and Singh, I. S., *Curr. Sci.*, 1967, 36, 365.

### INCOHERENT SCATTERING CROSS-SECTIONS OF GAMMA-RAYS IN Be, C, Mg AND S

To assess the effect of electron binding on the incoherent scattering cross-sections of gamma-rays on a quantitative basis and to check the theoretical estimations of the same, especially in low Z elements a method has been evolved

utilising the 'subtraction technique' by Ramana Rao *et al.*<sup>1</sup> From the total experimental gamma-ray cross-sections the theoretically estimated other partial cross-sections, except the incoherent scattering cross-sections, are subtracted. The ratio of the remainder to the free electron scattering cross-section is taken as a measure of the effect of electron binding. But this type of estimation of the effect on a quantitative basis is bound by the condition that theoretical partial cross-sections that are to be subtracted should be estimated very accurately. If the investigations are carried out at low energies (below 1.02 MeV) the partial cross-sections that are to be subtracted are due to the photoelectric effect and coherent scattering. If also the investigations are restricted to very light elements the contribution due to partial cross-sections (theoretical) that is to be subtracted will be smaller and thus very high accuracy can be obtained. In other words this method is well suited for estimating the effect of electron binding on the incoherent scattering cross-sections of gamma-rays on a quantitative basis in very light elements. Utilising this method the effect has been estimated in the energy region 30 to 130 keV in elements Be, C, Mg and S, so that the effect, as well as its variation with energy and Z can be studied.

The total experimental gamma-ray cross-sections in the elements Be, C, Mg and S in the energy region 30 to 130 keV are taken from the data of McCrary *et al.*<sup>2</sup> These are the measured cross-sections utilising Bragg diffraction monochromator. The theoretical photoelectric cross-sections are taken from the

TABLE I  
Ratios of bound to free electron scattering cross-sections

Energy in keV		Be	C	Mg	S
30-04	Experimental :	0.90 ± 0.02	0.89 ± 0.03	0.77 ± 0.09	..
	Theoretical :	0.96	0.94	0.88	
40-04	Experimental :	0.93 ± 0.01	0.92 ± 0.02	0.82 ± 0.05	..
	Theoretical :	0.97	0.96	0.92	
50-04	Experimental :	0.95 ± 0.01	0.94 ± 0.01	0.87 ± 0.04	0.84 ± 0.06
	Theoretical :	0.98	0.97	0.94	0.92
60-04	Experimental :	0.96 ± 0.01	0.95 ± 0.01	0.90 ± 0.02	0.86 ± 0.04
	Theoretical :	0.98	0.97	0.95	0.93
70-04	Experimental :	0.97 ± 0.01	0.96 ± 0.01	0.93 ± 0.01	0.90 ± 0.02
	Theoretical :	0.99	0.98	0.96	0.94
100-06	Experimental :	0.98 ± 0.01	0.98 ± 0.01	0.95 ± 0.01	0.94 ± 0.01
	Theoretical :	1.00	0.99	0.98	0.97
130-30	Experimental :	1.00 ± 0.01	0.99 ± 0.01	0.98 ± 0.01	0.96 ± 0.01
	Theoretical :	1.00	1.00	0.99	0.99

data of Hubbell and Berger.<sup>3</sup> The coherent scattering cross-sections based on Hartree-Fock Slater Model are taken from the data of Brown.<sup>4</sup> Utilising these data and the free electron scattering cross-section data the ratios of experimental incoherent scattering cross-section to free electron scattering cross-sections are estimated. These ratios are also determined utilising the theoretical bound electron scattering cross-sections reported by Brown,<sup>5</sup> based on Thomas-Fermi Model. The experimental as well as the theoretical ratios are given in Table I. The errors estimated are the maximum possible errors rather than probable errors.

It can be seen from Table I that the values of both the theoretical as well as experimental ratios increase as the energy increases and as  $Z$  decreases. It can also be seen that at all energies and in all elements the experimental values are smaller than the theoretical values. Leaving 1-2% deviation from the existing deviation, due to any other possible cause the following conclusions can be drawn:

Good agreement can be observed between the theory and experiment within the range of experimental errors at and above 60 keV in Be and C and at 130 keV in Mg. At all other energies in all elements deviations exist between the theory and experiment. These deviations can be attributed to the overestimations in the theoretical incoherent scattering cross-sections based on Thomas-Fermi Model. In other words the effect of electron binding on the incoherent scattering cross-sections exceeds that predicted by Thomas-Fermi Model in the energy region where the deviations exist.

The Laboratories for Nuclear Research,  
Andhra University,  
Waltair (India), November 23, 1967.  
K. PARTHASARADHI.

1. Ramana Rao, P. V., Rama Rao, J. and Lakshminarayana, V., *Proc. Phys. Soc.*, 1965, 85, 1081.
2. McCrary *et al.*, *Phys. Rev.*, 1967, 153, 307.
3. Hubbell, J. H. and Berger, M., *Engineering Compendium on Radiation Shielding* (IAEA, Vienna), Ed. R. Jaeger, Springer-Verlag, Berlin.
4. Brown, W., *Boeing Co. Report*, D2-125136-1 December 1966).
5. —, *Ibid.*, D3-125137-1 December 1966.

## THE KINETICS OF THE ADDITION OF BROMINE TO OLEFINIC COMPOUNDS

BROMINE-ADDITION to unsaturated compounds and substitution of bromine in the benzene ring are two reactions having some common kinetic features. In dry acetic acid medium, both the reactions are known to be electrophilic, of the third order and involve neutral molecules of bromine.<sup>1-4</sup> Some of our results on aromatic bromine substitution have been published.<sup>5</sup> The chief objects of the present work are to determine the total order and the individual reactant orders of the reaction by integration and differential methods, by which the results could be mutually checked,<sup>6</sup> and then to evaluate the Arrhenius and thermodynamic parameters.

Dry acetic acid was used as the solvent. Methacrylamide and acrylamide were the olefinic substrates. No kinetic study has been made so far on the addition of bromine to these two unsaturated compounds. The other experimental techniques were as described elsewhere.<sup>5-7</sup>

With equimolar initial concentrations of substrate (methacrylamide) and bromine and using the appropriate integrated third-order rate equation,<sup>5</sup> the total order of the reaction was found to be three, as shown in Fig. 1

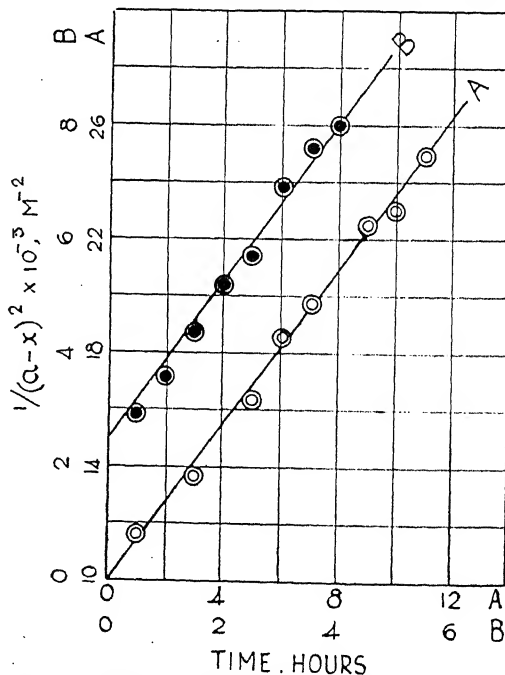


FIG. 1. Methacrylamide-bromine reaction in acetic acid at 30°C, with equimolar initial concentration of reactants. Plots showing over-all third-order kinetics. A, 0.01 M; B, 0.02 M.



(Straight lines A and B). The plots of  $1/(a-x)^2$  against  $t$  are linear (slope  $= 2k_3$ ) with intercepts of  $1/a^2$  on the zero-time ordinate. Here  $a$  and  $(a-x)$  denote, respectively, the concentrations of bromine present initially and after a time interval  $t$  and  $k_3$  is the third-order rate constant. The values of  $k_3$ , obtained from the slopes of the lines, are, respectively,  $0.185$  and  $0.191 \text{ M}^{-2} \text{ sec}^{-1}$ .

The correctness of the above values was verified by the "isolation method" and, incidentally, the order with respect to bromine was also established. When the olefinic substrate was present in large excess, compared to bromine, the reaction obeyed the integrated second-order rate equation.<sup>5</sup> This is shown in Fig. 2 (Straight

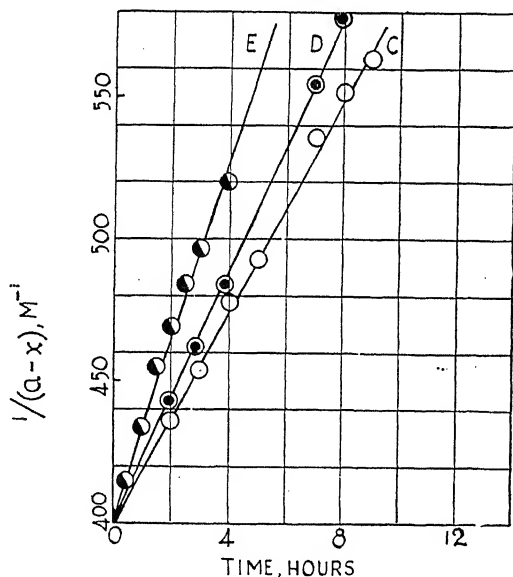


FIG. 2. Methacrylamide-bromine reaction in acetic acid at  $30^\circ\text{C}$ . Plots showing pseudo second-order kinetics with respect to bromine. Initial concentration of bromine is  $0.0025 \text{ M}$  in each case. Initial concentrations of methacrylamide, C,  $0.0250 \text{ M}$ ; D,  $0.0375 \text{ M}$ ; E,  $0.0500 \text{ M}$ .

lines C, D and E). Plots of  $1/(a-x)$  against time are linear with an intercept of  $1/a$  on the zero-time ordinate. The order with respect to bromine is, therefore, two. The slopes of the lines C, D and E give a pseudo-second-order rate constant which can be denoted by  $k_2'$  and whose value depends on the concentration of the substrate. We can now write

$$-\frac{d[\text{Br}_2]}{dt} = k_2' [\text{S}]^m [\text{Br}_2]^2 \quad (1)$$

where  $[\text{S}]$  represents the concentration of the olefinic substrate and  $m$  is the order with respect to substrate. It then follows that

$$k_2' = k_3 [\text{S}]^m \quad (2)$$

This equation was found to be valid only when  $m$  was unity, i.e., a plot of  $k_2'$  against  $[\text{S}]$  was linear and passed through the origin, the slope  $k_3$  having a value of  $0.175 \text{ M}^{-2} \text{ Sec}^{-1}$ . This is in very good agreement with the values obtained from lines A and B. These results are consistent with the fact that the over-all reaction is of the third-order.

Similar kinetic results were obtained for the acrylamide-bromine reaction in dry acetic acid. In order to calculate the Arrhenius activation energy, experiments were carried out at  $20^\circ$ ,  $30^\circ$ ,  $40^\circ$  and  $50^\circ \text{C}$ . Third-order reactions have low activation energies and to get accurate values of  $E$  from Arrhenius plots, at least a  $10^\circ \text{C}$ . interval is very essential. In the present case, satisfactory Arrhenius plots were obtained. Arrhenius activation energy ( $E$ ), pre-exponential factor ( $A$ ), entropy of activation ( $\Delta S^\ddagger$ ) and free-energy of activation ( $\Delta F^\ddagger$ ) are given in Table I. The values of  $\Delta S^\ddagger$  are in the expected region for a third-order reaction.

TABLE I  
Arrhenius and thermodynamic parameters for olefin-bromine reaction in acetic acid

Olefin	E K. Cal. mole <sup>-1</sup>	A M <sup>-2</sup> Sec. <sup>-1</sup>	$\Delta S^\ddagger$ E.U.*	$\Delta F^\ddagger$ K. Cal. mole <sup>-1</sup>
Acrylamide	11.6	$2.87 \times 10^7$	-26.5	19.6
Methacrylamide	9.5	$1.25 \times 10^6$	-32.8	19.4

\* Concentration unit, mole. litre<sup>-1</sup>.

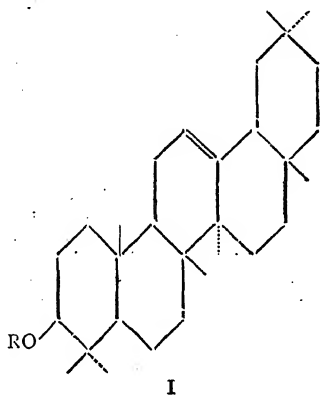
Physical Chemistry Dept., S. VISWANATHAN.  
University of Madras, R. GANESAN.  
Madras-25, December 5, 1967.

- Hine, J., *Physical Organic Chemistry*, McGraw-Hill and Kogakusha Co. Ltd. (Tokyo), 1962, p. 217.
- Robertson, P. W., Clare, N. T., McNaught, K. J. and Paul, G. W., *J. Chem. Soc.*, 1937, p. 335.
- White, E. P. and Robertson, P. W., *Ibid.*, 1939, p. 1509.
- De La Mare, P. B. D. and Ridd, J. H., *Aromatic Substitution, Nitration and Halogenation*, Butterworths, London, 1959, p. 123.
- Seshadri, K. V. and Ganesan, R., *Curr. Sci.*, 1964, **33**, 366.
- Laidler, K. J., *Chemical Kinetics*, McGraw-Hill, New York, 1950, p. 13.
- Seshadri, K. V., *Ph.D. Thesis*, University of Madras, 1965.

# CHEMICAL EXAMINATION OF DIOSPYROS SPECIES

## Part VI. The Triterpenes of the Leaves of *D. sylvatica*

DURING our scheme of a study of the triterpenes of *Diospyros* species,<sup>1-3</sup> the leaves of *D. sylvatica* were examined and the examination revealed a new triterpene alcohol besides  $\alpha$ -amyrin (I; R=H) and bauerenol (II, R=H).



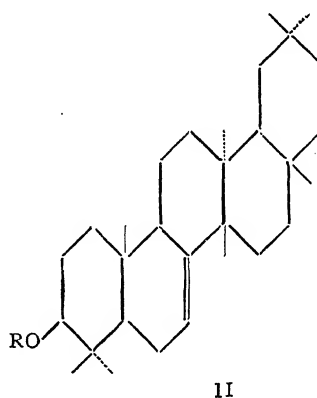
From the petroleum ether extract of the powdered leaves (2 kg.), a colourless crystalline solid (9 g.) separated out upon concentration. This was found to be a mixture (m.p. 160–80°) of three compounds on thin layer chromatogram using Silica gel G and chloroform as the solvent system. Separation of the mixture by chromatography on alumina was found to be impracticable. It was therefore benzoylated (*py*-benzoyl chloride) and the mixture of benzoates was separated into three fractions by careful fractional crystallisation from chloroform-ethanol (1:1).

Fraction A (6 g. m.p. 192–94°) after two more crystallisations, came out as colourless needles, m.p. 194–96° ( $\alpha$ )<sub>D</sub><sup>30</sup> + 93°, identical with  $\alpha$ -amyrin benzoate by direct comparison with an authentic sample.<sup>4</sup> On alkaline hydrolysis, pure  $\alpha$ -amyrin was secured (I, R=H) m.p. 184–86° ( $\alpha$ )<sub>D</sub><sup>30</sup> + 90°; acetate (I, R=Ac) m.p. 244–46° ( $\alpha$ )<sub>D</sub><sup>30</sup> + 75°, ketone m.p. 122–24°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 110°.

Fraction B (0.5 g. m.p. 254–56°) crystallised as colourless needles from ethanol; m.p. 258–60°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 15°, identified as bauerenyl benzoate (II, R=Bz) by comparison with an authentic sample.<sup>2</sup> Alkaline hydrolysis furnished pure bauerenol (II, R=H) m.p. 208–10° ( $\alpha$ )<sub>D</sub><sup>30</sup> – 20°;

acetate (II, R=Ac), m.p. 282–84°, ( $\alpha$ )<sub>D</sub><sup>30</sup>  $\pm$  0°; ketone m.p. 229–31°, ( $\alpha$ )<sub>D</sub><sup>30</sup> – 72°.

Fraction C (0.2 g. m.p. 244–46°) crystallised from methanol as colourless plates, m.p. 244–46°; ( $\alpha$ )<sub>D</sub><sup>30</sup> + 90°. Alkaline hydrolysis furnished a mono-hydroxy triterpene (C<sub>30</sub>H<sub>50</sub>O) m.p. 206–08°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 75°. It formed a mono-acetate, m.p. 216–18°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 85°; and a monoketone, m.p. 184–86°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 85°. It appears to be a new triterpene, being different from  $\alpha$  or  $\beta$ -amyrins (m.m.p., I.R. and T.L.C.)



as well as with any known monohydroxy triterpenes. This is further confirmed by the following reactions. Its acetate did not undergo any transformation with CHCl<sub>3</sub>-HCl, nor did it yield a diene with selenium dioxide when refluxed for 17 hours, in glacial acetic acid. With chromium trioxide in acetic acid, the acetate gave rise to an uncrystallisable substance whose I.R. spectrum revealed the presence of an  $\alpha$ - $\beta$  unsaturated ketone in the molecule ( $\nu$ <sub>max</sub> 1,660 cm.<sup>-1</sup>). This peak is significantly absent in the parent acetate. The n.m.r. spectrum of the acetate accounted for an olefinic proton at  $\tau$  4.78 (triplet J = Z cps) and the 3 $\alpha$  H occurs as multiplet between  $\tau$  5.25–5.60. The mass spectrum of the acetate showed close resemblance with the fragmentation pattern of  $\alpha$ -amyrin acetate<sup>5</sup> except for one extra peak at m/e 272. This data shows that the new monohydroxy triterpene is closely related to the amyryns.

All compounds reported above analysed satisfactorily; the optical rotations were recorded in chloroform solutions.

Our thanks are due to Prof. A. J. Birch for facilities to take n.m.r. and mass spectra and one of us (C. S. Rao) is grateful to the

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Dept. of Chemistry, L. RAMACHANDRA ROW.  
Andhra University, C. SANKARA RAO.  
Waltair, November 23, 1967.

1. Ramachandra Row, L., Sankara Rao, C. and Sundara Ramaiah, T., *Curr. Sci.*, 1964, 53 (12), 367.
2. —, — and —, *Ibid.*, 1966, 35 (18), 457.
3. —, — and —, *Ibid.*, 1966, 35 (18), 458.
4. Rangaswamy, S., Venkata Rao, E. and Suryanarayana, M., *Ind. J. Pharm.*, 1961, 23, 122.
5. Budzikiewicz, H., Wilson, J. M. and Djerassi Carl, *J. Amer. Chem. Soc.*, 1963, 85, 3688.

### HISTO-MORPHOLOGY OF THE OVARIOLE IN *PHEROPSOPHUS* *HILARIS*, FABR. (CARABIDAE: COLEOPTERA)

*Pheropsophus hilaris*, Fabr. is a predacious, medium-sized (about 15 mm. in length) carabid beetle occurring throughout South India. Since this beetle feeds on some crop pests, it may be regarded as a beneficial insect. Andrews (1929) emphasized the role of Carabidae in the biological control of insect pests. The general biology of *Pheropsophus* has been described by Kalyanam (1967). Since the reproductive system of Carabidae has deserved investigation, a study of this system in *P. hilaris* was undertaken. While a full description of the system will be published elsewhere, some interesting observations on the ovariole of this insect are reported here.

The beetles were collected from the field and kept alive in the laboratory on a diet of dried frog-meat and water. On repeated dissection and counting, it was found that each ovary contains thirty-six ovarioles. Previous reports on the structure of coleopteran ovaries, as reviewed by Datta Gupta and Kumar (1963), reveal great variation in the number of ovarioles per ovary ranging from one to fifty-four.

A single ovariole of *Pheropsophus* is a typically tapering egg-tube of polytrophic type (Fig. 1, A). In the egg-tube, the bulging oocytes alternate with narrow necks of nurse cells or trophocytes. At the distal end of the ovariole lies the germarium which gives rise to oocytes, trophocytes and follicle cells. Beyond germarium the egg-tube is attenuated into a thin filament.

Ovarioles were fixed in Carnoy's acetic-alcohol and dehydrated in alcohol. Methyl benzoate was used as clearing agent before embedding in paraffin. Longitudinal sections

of 8  $\mu$  thickness were cut and stained with Delafield's hematoxylin.

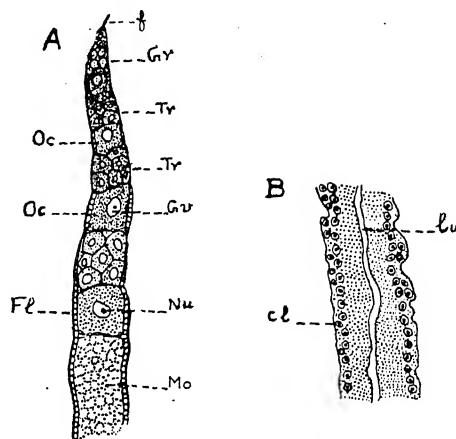


FIG. 1, A and B. Fig. A. Longitudinal section of ovariole. *f*, Filament; *Gr*, Germarium; *Tr*, Trophocytes; *Oc*, Oocyte; *Gr*, Germinal vesicle; *Fl*, Follicle; *Nu*, Nucleolus like body; *Mo*, Ripe oocyte (Drawn with camera lucida). Fig. B. Longitudinal section of corpus luteum. *lu*, Lumen of the empty follicle; *cl*, Cells of corpus luteum (Camera lucida).

Each ovariole is covered by the outer membranous tunica propria which is syncytial as observed by Bonhag (1958). On the inside of tunica propria, there is no clearly organised epithelium in the distal part of the ovariole. But lower down the egg-tube where growing oocytes are present, a well-formed follicular epithelium lies inside tunica propria. The alternating oocytes and groups of trophocytes occur serially in the egg-tube. In *Pheropsophus*, there are seven trophocytes for each oocyte. The trophocytes of a growing oocyte lie anterior to it. The oocytes and trophocytes are separated by thin septum of squamous follicular cells.

The follicle consists of cuboidal cells around oocytes. It is indistinct around the region of trophocytes. Posterior to the ripe oocyte at the proximal end of the ovariole, there is a plug of epithelial cells. This plug breaks down at the time of ovulation.

After release of the fully grown egg, the empty follicle collapses as aptly described by Snodgrass (1935) and forms the corpus luteum (Fig. 1, B). In the formation of corpus luteum there is drastic transformation of the cellular constitution of the follicle. There is condensation of chromatin and the cytoplasmic region becomes elaborate. Previous workers like Wigglesworth (1953) and Singh (1964) have stated that corpus luteum is a temporary structure formed by the disintegrated follicle. Cell

multiplication has not so far been reported. But we found from cell counts that there is cell multiplication (at least a doubling of number in preovulatory follicle) during the formation of corpus luteum from the collapsed follicle. Corpus luteum, though brief in existence, appears from its cell structure to play some role in the ovarian cycle of the insect. Measurements of different parts of the ovariole in *Pheropsophus* are as follows:

Length of ovariole excluding filament	.. 2.1 mm.
Length of filament	.. 0.75 mm.
Diameter of germarium	.. 0.03 mm.
Length of ripe oocyte	.. 0.55 mm.
Breadth of ripe oocyte	.. 0.22 mm.
Diameter of germinal vesicle	.. 0.13 mm.
Diameter of follicle cell	.. 0.01 mm.
Diameter of cell in corpus luteum	0.01 mm.
Diameter of nucleus in corpus luteum	.. 0.005 mm.

Our thanks are due to Prof. R. V. Seshaiya and the Zoological Survey of India for identification of the beetle and to the authorities of Pachaiyappa's College, Madras, for facilities.

Post-Graduate Dept. of N. P. KALYANAM.  
Zoology, K. SHANMUGHAM.  
Pachaiyappa's College,  
Madras, November 30, 1967.

1. Andrews, H. E., *Fauna of British India* (Coleoptera: Carabidae), 1929, 1, 31.
2. Bonhag, P. F., *Ann. Rev. Ent.*, 1958, 3, 137.
3. Datta Gupta, A. K. and Ravindra Kumar, *Ind. J. Ent.*, 1963, 25, 147.
4. Kalyanam, N. P., *Common Insect of India*, Asia Publishing House Ltd., Bombay, 1967.
5. Singh, T., *Ind. J. Ent.*, 1964, 26, 373.
6. Snodgrass, R. E., *Principles of Insect Morphology*, McGraw Hill Book Co., New York, 1935.
7. Wigglesworth, V. B., *Principles of Insect Physiology*, Methuen & Co. Ltd., London, 1953.

**PSEUDOEMBATA ACUTIPODA GEN.  
ET SP. NOV. (ROTIFERA:  
BDELLOIDEA), AN EPIZOIC ROTIFER**

DURING investigations on the biology of a caridean shrimp, *Caridina* sp., one of the problems was to rear the larvæ to adults. These larvæ invariably succumbed a few days after hatching as they were found heavily infested with an epizoic rotifer belonging to the order Bdelloidea. Later, it was observed that the adults too carried these rotifers from whom probably the larvæ receive their infection. Among the Bdelloid rotifers, members of the genus *Embata* are known to lead an epizoic life on the gill plates

and gill chambers of amphipods, isopods, crayfish and insect larvæ.<sup>3</sup>

Detailed examination of the present material shows that these rotifers combine most of the features characteristic of the genus *Embata* and a few characters of the closely related genus *Philodina*, both belonging to the family Philodinidae. Therefore, it is proposed to describe these rotifers as belonging to a separate genus *Pseudoembata* due to the preponderance of *Embata* characters.

*Pseudoembata acutipoda* GEN. ET SP. NOV.

*Structure of the individual.*—The clearly transparent animal has a total length of about 350  $\mu$  (Fig. 1, A). The digestive tube is light or 'dark' yellowish-brown. The cuticle is thin and smooth with a few longitudinal folds. The trochal disc or the wheel-organ is wider than the neck. Eye spots are located just above the mastax and are light red in colour. Rostrum is long and broad (Fig. 1, B). Dorsal antenna narrows towards the tip with a notch on one side (Fig. 1, C). The mastax is of the ramate type, typical of Bdelloidea (Fig. 1, D). Fulcrum is absent, and each ramus having two of their teeth thickened in the middle region.<sup>2</sup> The trunk region is distinctly broader than the neck and passes gradually into the foot. Foot is less than half of the total length and consists of four segments. Four toes are present which are almost of equal size (Fig. 1, E). Spurs are not very long and are closely situated parallel to each other, tapering towards their tips. The interspace between them is one-fourth of the diameter of the spur at its base (Fig. 1, F). These rotifers are oviparous and the eggs have a mean size of 166  $\mu$  (length) and 77  $\mu$  (width) (Fig. 1, G).

*Habitat.*—These rotifers are distributed mostly on the extremities of the animal, especially at their joints (Fig. 1, H). Occasionally, a few of them were lodged on the gill lamellæ within the gill chamber. The eggs were also attached to the body of the host. It was almost always the anterior region which contained the maximum number of individuals while the posterior half of the host had very little or none of these rotifers. Evidently, these rotifers being filter-feeders like their hosts, may be benefited by remaining in the anterior region where the water currents are set up for respiration and feeding, by the shrimps. The larvæ reared in the laboratory were found heavily infested and were incapable of any movement. Further, it is thought likely that these rotifers also

compete with the food available for the larvæ as seen in a simple experiment. When these larvæ were fed with yeast, the attached rotifers too, actively collect the yeast particles for their own nutrition, thereby depleting the available food for the larvæ. It will be of interest to study whether these epibionts do compete for the food of their hosts in natural environments also.

placed, and in the foot being less than half of total length, which are characters of the genus *Philodina*.<sup>2</sup> Further, this genus differs from *Embata* in being oviparous yet possessing eyespots.<sup>1</sup> Thus, the present genus, while combining both the generic characters, has a closer affinity to genus *Embata* and hence the name *Pseudoembata*. The specific name refers to the structure of the spurs.

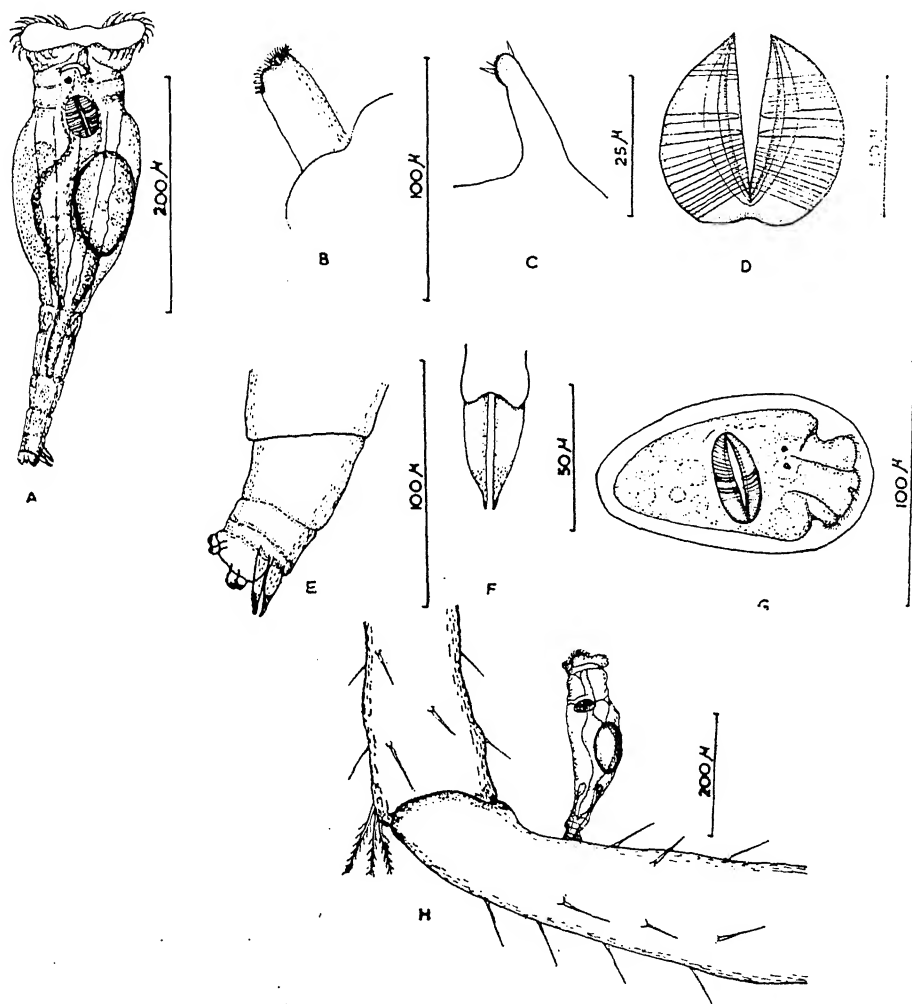


FIG. 1. A. Entire animal. B. Rostrum. C. Dorsal antenna. D. Mastax. E. Foot with toes and spurs. F. Spurs enlarged. G. Egg with an advanced embryo. H. Rotifer attached to the host.

**Remarks.**—These rotifers resemble the members of the genus *Embata* in the possession of a broad wheel-organ, stout foot, four toes, in gross internal structure and in their mode of life.<sup>1</sup> However, they differ from the above genus in the spur being short and closely

The authors are grateful to Professor S. Krishnaswamy, for suggesting this problem and for the encouragement and help in the preparation of this paper. Our thanks are due to Dr. W. T. Edmondson, University of Washington, Seattle, U.S.A., for the supply of relevant

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Dept. of Zoology, M. JOHN WYCLIFFE.  
Madurai University, R. GEORGE MICHAEL.  
Madurai-2, December 9, 1967.

1. Bartos, E., *Vestník Českosl. Zoologické Společnosti*, 1951, 15, 241.
2. Edmondson, W. T., *Freshwater Biology*, John Wiley & Sons, Inc., New York, 1959, p. 1248.
3. Hyman, L. H., *The Invertebrates*, McGraw-Hill Book Company, Inc., 1951, 3, 572.

### OBSERVATIONS ON THE RATE OF HEART-BEAT IN THE VARIOUS STAGES OF THE TIGER BEETLE, *CICINDELA CANCELLATA* DEJ.

THE rate of contraction of the dorsal blood vessel in insects is known to be dependent on many factors such as general metabolism, activity, temperature, stage of development and the presence of various agents.<sup>1</sup> The rate of contraction of the dorsal vessel in the various stages has been observed by Newport<sup>2</sup> in *Sphinx ligustri* and by Masera<sup>3</sup> in *Bombyx mori*.

and through the intersegmental membranes in the pupa and adult. The immature stages under observation were kept in an open petri dish containing some moist sand taken from the rearing cages. The rates of heart-beat were measured with the help of a stop-watch. For each stage, twenty replications were made. The statistical data relating to these observations are contained in Table I.

It is noted from the results that the rate of heart-beat in *Cicindela cancellata* is highest during the first instar and that it progressively decreases during development, through successive stages. The average rates for the three instars are, 68, 50 and 29 beats per minute respectively. The rate drops to the lowest and apparently to a common level at the inactive phase just before moulting and during the pupal stage both of which show a rate of 19 beats per minute. The rate rises again to 63 beats per minute in the adult.

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TABLE I  
Number of heart-beats per minute

Stage	I instar	II instar	III instar	II instar just before moulting	Pupa	Adult
Mean	68.2	50.2	29.2	18.85	19.25	62.55
Range	56-78	35-60	20-42	13-28	10-28	48-79
Standard deviation	6.56	7.07	6.08	4.12	1.85	8.02
Standard error	1.47	1.6	1.36	0.41	0.92	1.8

This investigation was designed to record observations on the rate of heart-beat in *Cicindela cancellata*, in the various stages, viz., the three instars, the inactive stage just before moulting, in the pupa and in the adult. The observations were made in the laboratory at a temperature of  $27 \pm 2^\circ \text{C}$ . and  $66 \pm 5\%$  relative humidity.

*Cicindela cancellata* was collected from the Malabar Christian College compound and was reared in the laboratory in special rearing cages designed by Soans.<sup>4</sup> The various immature stages of the insect were collected from the cages and observations were made under a binocular dissecting microscope. The contractions of the dorsal vessel could be easily observed through the integument of the larvae

1. Beard, R. L., *Insect Physiology*, John Wiley & Sons, New York, 1953.
2. Newport, G., *Phil. Trans. Roy. Soc.*, 1837, 127, 259.
3. Masera, E., *Riv. Biol.*, 1933, 15, 225.
4. Soans, A. B. (Unpublished matter).

### A STUDY OF THE BIOCHEMICAL COMPOSITION OF THE SEA STAR *OREASTER HEDEMANNI*

VERY few investigators have analysed the biochemical composition of the echinoderms<sup>1,2</sup> of the east coast of India. The present note deals with the biochemical composition of different tissues of the sea star *Oreaster hedemanni*. This investigation was started in order to understand the distribution of organic food materials in major subdivisions of the body.

TABLE I  
The biochemical composition of the sea star *Oreaster hedemanni*\*

Tissue	Water	Ash	Protein	Non-protein nitrogen	Lipid	Carbohydrate
1+ Body wall ..	28.15 20.26-32.25	56.12 40.85-66.11	1.25 1.71- 2.86	1.82 0.79- 2.18	4.00 2.89- 6.82	..
2 Feet ..	75.84 61.82-82.45	15.42 10.82-18.65	27.75 13.63-34.25	4.69 3.80- 5.32	10.40 6.62-12.45	7.12 5.56-10.38
3 Stomach ..	70.75 58.62-78.15	10.32 6.82-14.75	24.96 10.69-30.94	4.90 3.54- 6.21	19.40 12.15-22.65	7.50 4.00-10.38
4 Intestinal caeca ..	68.16 48.42-78.25	11.38 7.85-16.32	28.44 13.63-35.38	5.07 3.60- 7.89	17.00 10.65-21.24	11.00 9.63-14.20
5 Pyloric caeca ♂ ..	62.82 51.28-70.44	4.80 2.74- 6.42	18.88 9.22-23.25	6.91 3.90- 9.22	28.68 20.12-42.58	5.28 4.61- 9.22
6 Pyloric caeca ♀ ..	63.86 60.24-72.64	6.72 2.16- 8.86	20.75 10.63-28.54	5.60 4.14- 8.69	31.86 23.85-50.16	6.72 5.00- 8.33
7 Gonad ♂ ..	72.25 62.82-78.65	10.25 4.80-13.50	31.26 18.56-45.5	6.64 3.00- 9.00	10.12 7.16-17.85	6.16 3.68-12.37
8 Gonad ♀ ..	74.75 68.12-81.26	11.16 4.00-12.65	34.33 17.44-48.56	5.21 3.75- 6.30	13.86 8.20-20.25	5.25 4.20-11.75

\* The values reported are mean values and ranges. The water content is expressed as per cent wet weight. All the others are in per cent dry weight.

The tissues used in the present study are the calcareous shell, tube feet, pyloric and intestinal caeca, and gonads (male and female). The animals used for the present investigation were collected from Tondi, about 70 miles from Madurai. The methods used have been already described.<sup>3,4</sup>

It may be seen from Table I that water content is low in the calcareous shell and body-wall (28.15%) but reaches a maximum value in gonads (72.25% ♂ 74.75% ♀) and tube feet (75.84%). The ash-content is very high in shell and body-wall (56.12%). Protein values range from 31.26% (♂) and 33% (♀) in the gonad, but is only 18.88% (♂) and 20.75% (♀) in the pyloric caeca. On the contrary, the lipid content is low in the gonad (10.12% ♂ ; 13.86% ♀) and very high in the pyloric caeca (28.68% ♂ ; 31.86% ♀). Carbohydrates do not vary significantly in the different tissues.

It is known that intensive biochemical synthesis takes place at the time of gametogenesis.<sup>5</sup> It may be pronounced in the ovaries than the testes, as can be seen from a comparison of the gonad indexes.<sup>6</sup> Similarly, large amounts of proteins are stored in the gonad whereas lipid is stored in the pyloric caeca only, which is considered to be the storage organs. Lipid appears to form the major portion of the storage material. The lipid content of the gonad is 11.99% (dry weight) whereas it is 30.27% in the pyloric caeca. Observation on lipid content in other organs of *Pisaster ochraceus*

suggests that space may be a limiting factor for the accumulation of organic materials by the pyloric caeca.<sup>7</sup> Accumulation of organic nutrients such as protein, lipid and carbohydrate are in the order of 26.26% ; 17.12% ; 7.41% in the male and 27.25% ; 18.50% ; 7.52% in the female. On a dry weight basis, the ash content is similar in both the sexes. A comparison of protein content of the gonads and the pyloric caeca shows an inverse relationship suggesting a possible transfer of organic food materials from the pyloric caeca to the gonads. Important organic food nutrients that appear to be transferred from the pyloric caeca to the gonads when the gametogenesis is initiated in *Oreaster hedemanni* include lipids, proteins and carbohydrates.

The author expresses his thanks to Prof. S. Krishnaswamy, for suggesting the problem and guidance.

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November 22, 1967.

1. Rao, K. S., *Curr. Sci.*, 1965, **34**, 87.
2. Giese, A. C. et al., *Comp. Biochem. Physiol.*, 1964, **12**, 367.
3. Rahaman, A. A., *Curr. Sci.*, 1965, **34**, 217.
4. —, *Proc. Ind. Acad. Sci.*, 1965, **62**, 188.
5. Giese, A. C., *Ann. Rev. Physiol.*, 1959, **21**, 547.
6. Rahaman, A. A., *Bull. Dept. Mar. Biol. Oceanogr., Univ. Kerala*, 1966, **2**, 1.
7. Mauzey, K. P., *Biol. Bull.*, 1966, **131**, 127.

# OCURRENCE OF *DENTALIUM* (SCAPHOPODA : MOLLUSCA) IN PULICAT LAKE

SCAPHOPODA are marine molluscs living half-buried in sand at the sea bottom from the littoral to a depth of 2,500 fathoms. Four species of *Dentalium* are known to occur around Krusadai and in Indian waters in general, of which *D. octangulatum* Donovan is said to be the commonest species.<sup>1-2</sup> Faunistic surveys of Indian brackish-waters like the Gangetic Delta,<sup>3</sup> Chilka Lake,<sup>4</sup> Ennur and Cochin<sup>5</sup> and Madras<sup>6</sup> do not include *Dentalium*.

Pulicat Lake is a large brackish-water lake, 35 miles north of the city of Madras. Earlier survey of this lake conducted by the Madras Fisheries Department<sup>7</sup> and our own surveys for the past four years have not been able to obtain *Dentalium* from this estuarine lake. On the 30th October 1967, the post-graduate zoology students of the Madras Christian College, while dredging near the 27th Milestone at the Moosamanai Lock on the Pulicat Lake, collected one live specimen of *Dentalium octangulatum* Donovan, dredged from about a meter-deep waters, just about 20 meters away from the shore. The salinity at this point was 28.42‰ and the bottom was sandy, admixed with large quantities of empty lamelibranch shells particularly those of *Meretrix casta*. Other live animals of the bottom fauna associated with *Dentalium* and dredged together were *Umbonium vestiarium*, *Calyptraea* (*Crucibulum*) *extinctiorum* (attached to empty shells of *Arca granosa* and *Ostrea madrasensis*) and *Ophiocnemis* sp. It is interesting that from the very same locality in the lake, we have collected from dredgings, large numbers of *Branchiostoma lanceolatum* (Pallas), earlier during the past two years.<sup>8</sup>

The present specimen of *Dentalium octangulatum* has the shell 22.0 mm. long and 3.0 mm. wide at the front end. It is well curved and has eight ribs. In live condition, the shell was milk-white in colour but in the preservative formalin, it is creamy-white.

This seems to be the first record of *Dentalium* from brackish-waters. The station, from which it is collected in the lake, is directly against the inflowing freshwater Buckingham Canal and during the flood seasons, salinity at this point goes down considerably low and, therefore, it would be interesting to study the extent to which a sedentary bottom-living animal

like *Dentalium* is able to withstand salinity fluctuations.

Department of Zoology, P. J. SANJEEVA RAJ.  
Madras Christian College,  
Tambaram, Madras-59,  
December 12, 1967.

1. Satyamurti, S. T., *Bull. Madras Govt. Mus. N.S. Nat. Hist.*, 1956, 1 (2), Part 7 2.
2. Hornell, J., *Indian Molluscs*, Bombay Natural History Society, Bombay, 1951.
3. Annandale, N., *Rec. Ind. Mus.*, 1907, 1, 39.
4. — and Kemp, S., *Mem. Ind. Mus.*, 1928, 5, 327.
5. Preston, H. B., *Rec. Ind. Mus.*, 1916, 12, 27.
6. Panikkar, N. K. and Aiyar, R. G., *Proc. Ind. Acad. Sci.*, 1937, 6 B, 284.
7. Chacko, P. I. et al., *Report on a Fishery Survey of the Flora and Fauna and Fisheries of the Pulicat Lake*, Madras State, India, 1953.
8. Sanjeeva Raj, P. J. and Azariah, J., *J. Mar. Biol. Ass. India*, 1968, 8 (2) (in press).

## EFFECTS OF THE LATEX OF *CARICA* *PAPAYA* AND *CALOTROPIS GIGANTEA* ON THE GROWTH OF THE ONION ROOT

THE root provides a favourable system for studying the effect of various external treatments on growth and differentiation in higher plants. The present study utilises this system for investigating the effect, on the growth of onion roots, of treatments with latex of *Calotropis gigantea* and *Carica papaya*. Latex was chosen for study because it has been shown to have both proteolytic<sup>1</sup> and bacteriolytic<sup>2</sup> properties.

Onion bulbs with roots grown to a length of about ¼ inch were divided into 9 groups and treated in jars containing 0.5, 2, 4 or 6 ml. of either latex in 80 ml. of tap-water. Control set received no treatment and was grown in tap-water only.

No visible effect of the treatment was noticed for 2 days. New roots started appearing in all treatments but their number was restricted in comparison to the control. The root growth was markedly retarded in the treated series (Table 1). For example, in 72 hours, while the untreated roots had attained a length of 2.5", the treated roots did not grow beyond an inch. It is also noted that treatment with 4 and 6 ml. of latex caused a complete inhibition of root growth.

Delayed appearance of the lateral root was another noticeable effect; the extent of delay being concentration dependent. Thus, while lateral roots appeared in treatment 0.5 ml. in



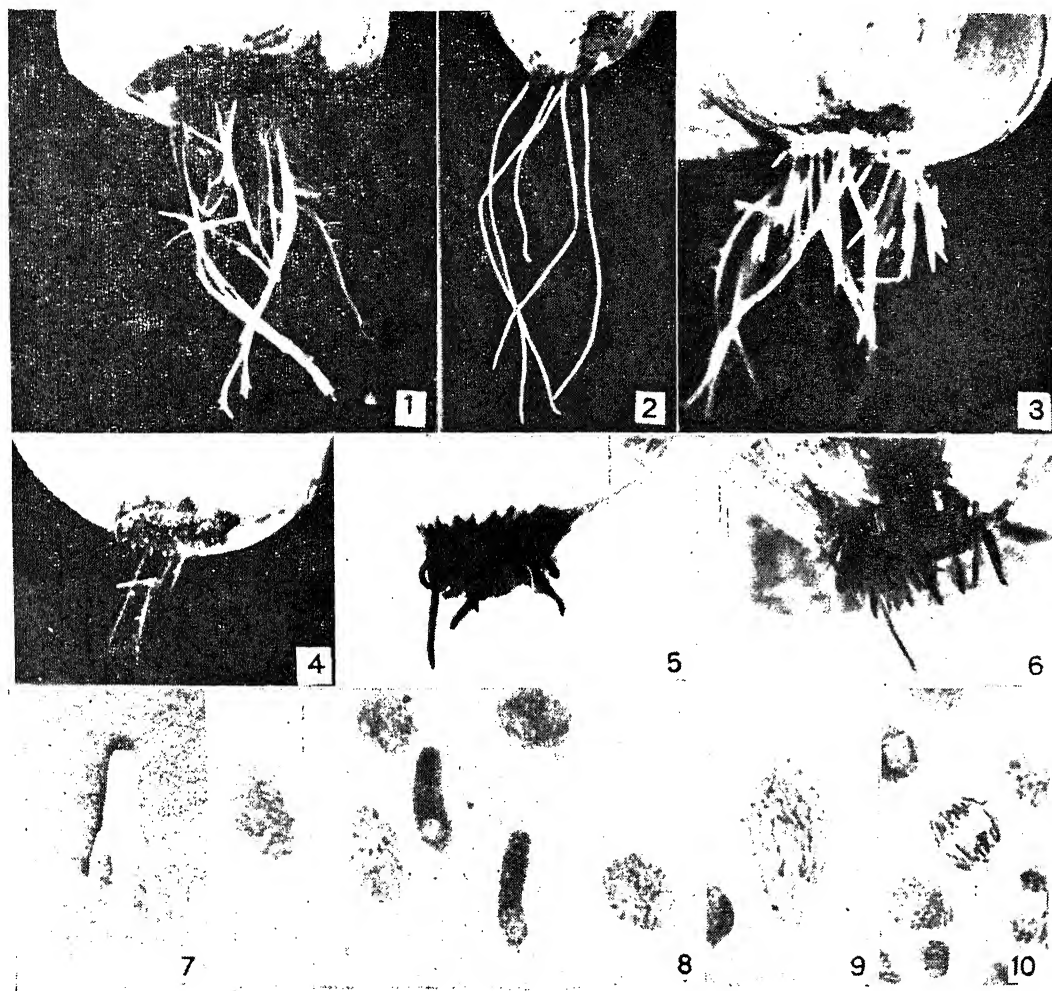
TABLE I

Concentrations in inches	Length of roots on 3rd day	On 5th day	On 10th day
Control	2.5	Growth continued	Roots long & slender
0.5 ml. of latex	1	"	Roots swollen
2 ml. "	0.5	"	"
4 ml. "	0.25	No growth, roots black and slender	No change
6 ml. "	0.25	"	"

8 days, they failed to appear in treatment with 2 ml. even after 10 days.

When the treated bulbs were allowed to recover in tap-water after 18 days of treatment, new roots appeared in treatments with 0.5, 2 and 4 ml. but the damage caused by 6 ml. treatment was irreversible and no new roots appeared even after the latex treatment was withdrawn.

Cytological studies were made in 2 ml. treatments with latex of both species. Several abnormalities were observed in the cells of the root meristem. Prominent among these,



FIGS. 1-10. Fig. 1. Lateral branches appearing in the treated root after 8 days. Fig. 2. Root growth in the control after 10 days. Fig. 3. New normal roots appearing in the treated bulb after transferring to fresh tap-water. Fig. 4. Lateral branches appearing in the treated root after 10 days. Fig. 5. Roots treated with 4 ml. of the calotropis latex. Fig. 6. Roots treated with 6 ml. of the latex. Fig. 7. Cut treated root enlarged to show the lateral roots. Fig. 8. Dissolution of the chromatin material in the nucleus. Fig. 9. Nucleus in prophase showing fibres. Fig. 10. Anaphase showing sticky bridges.

besides a general reduction in mitotic index, were giant cells with large nuclei, progressive reduction of staining with Feulgen reagent and chromosome stickiness leading to anaphase bridge formation.

The results of the present study underline the inhibitory effect of the latex on root growth. It has been found that the inhibition is primarily exercised against the meristematic cells. As a result, cells of the quiescent center in the root become active and give rise to lateral branches in roots treated with latex.

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Central College,  
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Dept. of Zoology, M. AZMATHULLA KHAN.  
St. Joseph's College,  
Bangalore, May 25, 1967.

1. Bose, S. M. and Madhva Krishna, W., *Bull. Cent. Lat. Res. Inst. Madras, India*, 1954, 3, 329.
2. Shukla, O. P. and Krishna Murthy, C. R., *J. Sci. and Ind. Res.*, 1961, 20 C, 225.

## INDOLE ACETIC ACID METABOLISM IN SOILS

RECENTLY Libbert and his associates<sup>1</sup> claimed that the auxin indole acetic acid (IAA) in the plant is actually contributed by the micro-organisms particularly bacteria present in the root systems. They concluded that the ability of higher plants to convert tryptophan to IAA is largely due to epiphytic bacteria living at the plant surfaces and discounted the importance of IAA synthesis in the plants. The IAA synthesizing potentials of some of the soils were therefore put to test with a view to assessing the importance of soil-borne IAA in influencing the plant IAA.

25 g. of finely powdered soils capable of passing through 2 mm. sieve were transferred to 500 ml. Erlenmeyer flasks containing 100 ml. of phosphate buffer at pH 7.0 with 0.005 M L-tryptophan and 5.0 g. of sucrose. The flasks were incubated in dark at  $26 \pm 3^\circ \text{C}$ . for 24 hr, filtered through Whatman No. 42 filter-paper and 50 ml. of the filtrate was adjusted to pH 3.0 with 2N HCl. The filtrate was extracted with equal volumes of ether at  $2^\circ \text{C}$ . for 3 continuous times. The ether was flash evaporated and the residue was dissolved in 2 ml. methanol.

The IAA in the methanol fraction was quantitatively estimated by the method of Gordon and Paleg<sup>2</sup> employing Salper reagent (1 ml. of 0.5 M  $\text{FeCl}_3$  in 50 ml. of 35%  $\text{HClO}_4$ ) after allowing the reaction mixture in the dark for 1 hr. for the maximum colour development. The absorbancy was read in a Klett Summerson colorimeter employing a green filter No. 52. The IAA was chromatographically separated<sup>3</sup> in *n*-butanol-acetic acid-water (4:1:1) and located by spraying with either Salkowski (1 ml. of 0.5 M  $\text{FeCl}_3$  in 50 ml. of 5%  $\text{HClO}_4$ ) or Ehrlich's reagent (0.5 g. of *p*-dimethyl amino benzaldehyde and 1 ml. concentrated HCl in 100 ml. of 95% ethanol).

It is evident from Table I that the IAA synthesizing ability of the soils considerably differed; Coimbatore clay harboured micro-organisms which synthesized the maximum amount of IAA while river sand favoured the least production of the auxin. Interestingly, addition of streptomycin at 1,000 ppm./ml. had little effect on IAA synthesizing ability.

TABLE I  
Synthesis of IAA from tryptophan by  
different soils

Soil type	Previous crop	IAA (mg./g. soil)
Coimbatore clay	.. Paddy	0.042
Vridhachalam red soil	.. Groundnut	0.005
Ooty Laterite	.. Wheat	0.024
Coonoor-Laterite	.. Peach	0.019
Coimbatore Black cotton	.. Cotton	0.011
Annamalai clay	.. Paddy	0.017
River sand	.. ..	0.006
Annamalai clay + Streptomycin	Paddy	0.016
Annamalai clay without L-tryptophan	Paddy	..

The IAA destroying ability of soils was also ascertained by adding 25 g. of clay soils to 100 ml. of 0.005 M IAA and 5 g. of sucrose at pH 7.0 in a phosphate buffer. The residual IAA in the filtrate was estimated at the end of 24 hr. by adding Salper reagent to 0.1 ml. of the filtrate. It was found (Table II) that in the Coimbatore clay, IAA was destroyed much more rapidly than Annamalai clay and the rate of degradation of IAA was relatively high in both the soils.

TABLE II  
Destruction of IAA by selected soil types

Soil type	IAA destroyed (mg./g. soil)
Coimbatore clay	1.200
Annamalai clay	1.080

The biochemical activities of the soil are directly related with the micro-organisms present in the soil<sup>4,5</sup> and from the data we conclude that soils contain both IAA synthesizing and destroying organisms and the IAA synthesizing activity was much more predominant than destruction as the data in Table I are the net difference between synthesis and destruction.

Although IAA may be readily present in the soil, its absorption and utilization by the plant is doubtful. IAA is transported in a polar direction in the plants;<sup>6</sup> hence the IAA synthesized by the micro-organisms in the root zone and in the soil should not theoretically contribute much to the IAA pool of the plant. IAA absorption by root system has long been known<sup>7-9</sup> and in cotton plants we noticed the transportation of IAA from root to the stem tip. However, Skoog<sup>9</sup> showed that such absorbed auxins are re-exported downward by the normal polar transport. Hence we conclude that the IAA synthesized by the soil micro-organisms might not contribute to the IAA pool of the plant.

Microbiology Lab., D. CHANDRAMOHAN.  
Annamalai University, A. MAHADEVAN.  
Annamalai Nagar,  
Madras, November 23, 1967.

1. Libbert, E., Wichau, S., Schiewer, U., Risch, H. and Kaiser, W., *Plan'a*, 1966, 68, 327.
2. Gordon, S. A. and Paleg, L. G., *Physiol. Plant*, 1957, 70, 37.
3. Mahadevan, A., *Phytopathol. Z.*, 1966, 57, 253.
4. Burges, N. A., *Micro-organisms in the Soil*, Hutchinson & Co., Ltd., London, 1958.
5. Rangaswami, G. and Venkatesan, R., *Micro-organisms in Paddy Soil*, Annamalai University, Annamalai Nagar, Madras, 1966.
6. Galston, A. W. and Purves, W. K., *Ann. Rev. Plant Physiol.*, 1960, 11, 239.
7. Hitchcock, A. E. and Zimmerman, P. W., *Contrib. Boyce Thompson Inst.*, 1935, 7, 349.
8. — and —, *Ibid.*, 1938, 9, 463.
9. Skoog, F., *Ann. J. Botany*, 1938, 25, 361.

#### OCCURRENCE OF BLUE LEAF-HOPPER *TYPHLOCYBA MACULIFRONS* MOTSCH ON RICE

OBSERVATIONS on the high yielding, short duration rice varieties which are very popular in India, have brought to light the occurrence of a new leaf-hopper causing serious damage to the crop both in the seed-bed stage and at later stages of vegetative growth. These leaf-hoppers are small, bluish in colour with

yellow pigmentation on the head and prothorax and with a conspicuous black dot on the vertex. This has been identified as *Typhlocyba maculifrons* M. (Fig. 1) and is the first record of its occurrence in rice.

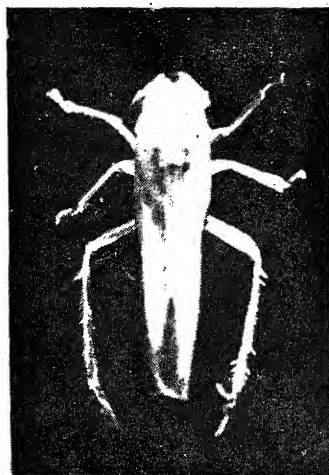


FIG. 1



FIG. 2. White spots and wavy lines on the leaf caused by *Typhlocyba maculifrons* M.

Nature of damage caused and details of its biology are as follows:

The leaf-hopper punctures and sucks the chlorophyll from the lamina with the result, the infested leaves show transparent wavy lines which confirm the oblique movement of the leaf-hopper (Fig. 2). The attack is confined mostly to the seedlings in the seed-bed which are at 2 to 4 leaf stage.

The female lays eggs singly or in batches of 2, 3 or 4 in the leaf-sheath and in the midrib, more often in the upper surface of the midrib. One female can lay upto a maximum of 64 eggs during the lifetime.

The eggs hatch in 10-11 days during the month of February when the maximum temperature is 31.6° C., the minimum is 16.0° C. and relative humidity is 61-62%. The first, second, third, fourth and fifth instars take 3, 3, 3, 2 and 2-3 days respectively. The total period from egg to adult is about 23-25 days.

The authors are thankful to Dr. E. O. Pearson, Director, Commonwealth Institute of Entomology, London, for identification of the leaf-hopper, and to Dr. S. Y. Padmanabhan, Director, for his kind interest and encouragement in this work.

Central Rice Res. Inst., P. ISRAEL.  
Cuttack-6, Orissa, B. C. MISRA.  
India, November 11, 1967.

#### EFFECT OF GIBBERELIC ACID ON THE EXPRESSION OF COCKSCOMB CHARACTER IN *ELEUSINE CORACANA*

Study of germplasm comprising nearly 900 world collections of *Eleusine coracana* Gaertn. a member of the minor millets, has presented a wide range of variation with regard to earhead morphology (Kempnana and Govindu, unpublished). Of this the one with 5 to 6 straight spikes (fingers) is by far the most common. As such it is regarded as the normal type in relation to others. Amongst the infrequent ones is the cockscomb earhead which, in addition to the usual 5 to 6 normal spikes, has 10 to 12 and sometimes exceedingly large number of smaller spikes arising from the branching of the main spikes.

Very little is known of the genetics of the earhead complex as a whole and particularly so of the cockscomb character. Nevertheless, what little is known from the contribution to the literature by Ayyangar *et al.* (1932, 1933) and also from the range of variation exhibited by the present material (Fig. 1) is enough to

conjecture the complex nature of the character. This suggests the possibility of its being governed by either multiple alleles or polygenes. What is relevant, however, in the context of this communication is the reaction of the cockscomb locus or loci to gibberellin treatment.



FIG. 1. Showing variation in earhead types in *Eleusine coracana*: one at the bottom centre is the cockscomb type

A widely cultivated variety H<sub>22</sub> is generally characterised by a normal head (Fig. 2) with usually 5 to 6, in any case not more than 9, long and straight spikes. A set of seedlings of this variety was sprayed twice with 60 ppm gibberellic acid (GA<sub>3</sub>), once at 30 days and again at 45 days age. Sixty out of seventy treated seedlings developed cockscomb heads (Fig. 2), while none did from a similar number of plants in control plot.



FIG. 2. Showing two types of earheads in *Eleusine coracana*: picture to the left represents normal earhead; one to the right represents cockscomb type.

The simultaneous occurrence in as many as 86% of the treated plants of the cockscomb character in the first treated generation itself in addition to its failure to recur in the

TABLE I

Type of earhead	Average No. of fingers per head	Average grain bearing area per ear in sq.cm.	Average No. of grains per head	Average wt. of grain/head in grams	Average dry wt. of head in grams	Grain to ear-head ratio by wt.
Normal earhead of $H_{22}$	7-10	25.02	941-10	2.77	3.38	80.30
Induced cockscomb head of $H_{22}$	13.00	36.56	1289.90	4.18	5.33	76.54

immediate succeeding generation ruled out the possibility of its mutational (gene) origin. The ready response of the character to gibberellin treatment would, therefore, suggest its relation to auxin levels.

That the cockscomb and non-cockscomb expressions are the attributes of nothing but two different auxin levels of the plant is fully borne out by further observation and data. The first and, rarely, the second tiller developed cockscomb heads while the rest produced normal heads. The observed dimorphism in the manifestation of the character can now reasonably be presumed to have been due to the treated plant varying in its auxin levels caused by the external application of gibberellin. In other words, cockscomb expression was the result of the temporary rise in the auxin position of the plant above the threshold level, while the reversion to normal character is an automatic indication of the reversion of the plant to normalcy in its auxin level. This is clearly analogous to the case of dwarf mutants in maize (Phinney, 1961). The apparent bipartite behaviour of the treated plant is thus an illustration of the supplementary action of the additional dose of gibberellin on one hand and the interrelationship between the auxin levels and the expression of the cockscomb character on the other.

Economics of the gibberellin-induced cockscomb habit are interesting from certain trends revealed by the data given in Table I.

From the data collected indications are available to prove the superiority of the gibberellin-induced cockscomb earhead. But this position is somewhat unstable as evident from the negative tendencies recorded in respect of grain to earhead ratio by weight. This could possibly be due to certain amount of infertility consequential to gibberellin treatment. However, more investigations are necessary before the practical feasibility of the phenomenon could be considered.

Univ. of Agricultural Sciences, Y. C. PANCHAL.  
Department of Botany, C. KEMPANNA.  
Bangalore-24, September 21, 1967.

1. Ayyanagar, G. N. R., Krishna Rao, P. and Warier, U. A., "Inheritance of characters in ragi, *Eleusine coracana*," *Ind. J. Agri. Sci.*, 1932, 2, 254.
2. "and", "Inheritance of characters in ragi, *Eleusine coracana*," *Ibid.* 1933, 3, 1072.
3. Phinney, B. O., *Plant Growth Regulation*, Iowa State University Press, Ames., 1961, p. 489.

#### FOSSIL WOOD OF ADENANTHERA AND SWINTONIA FROM THE TERTIARY OF ASSAM

Two new fossil woods are being recorded here from the Tertiary rocks of Hailakandi (24° 26' N : 92° 32' E), district Cachar, Assam. One of them is a fossil wood of *Adenanthera*. It shows the following anatomical characters:

*Growth rings* indistinct, appear to be delimited by smaller vessels. *Vessels* diffuse (Fig. 1), 144-204  $\mu$  in tangential diameter; intervessel pit-pairs vestured. *Parenchyma* vasicentric, rarely aliform to aliform-confluent and diffuse, sometimes crystalliferous. *Xylem rays* 1-3 (mostly 2) seriate, homocellular, consisting only of procumbent cells (Fig. 2). *Fibres* non-septate and thin-walled with wide lumina.

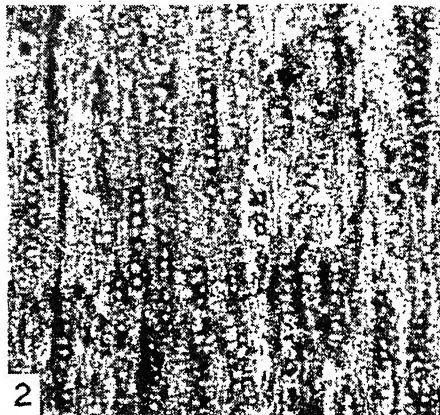
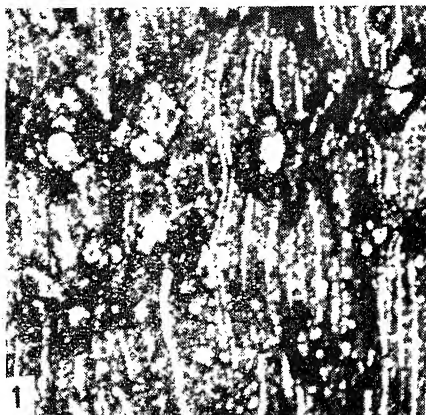
A detailed comparison with the modern woods indicates that the above fossil wood resembles closely with the extant species *Adenanthera pavonina*, Linn. of the family Leguminosae (Metcalfe and Chalk, 1950; Desch, 1957; Moll and Janssonius, 1914). It is, therefore, being named as *Adenantheroxylon pavoninum* gen. et sp. nov.

The other fossil wood referred to the modern genus *Swintonia* shows the following characters:

*Growth rings* indistinct. *Vessels* 100-288  $\mu$  in tangential diameter; intervessel pit-pairs, bordered, with lenticular orifices, 8-12  $\mu$  in diameter. *Parenchyma* vasicentric, aliform and aliform-confluent and in long and short apotracheal bands (Fig. 3). *Xylem rays* both

simple and fusiform with gum canals; normally 1-3 (mostly 2) seriate, those with gum canals 6-32 seriate (Fig. 4); ray tissue heterogeneous; ray cells crystalliferous. Fibres non-libriform, non-septate. Intercellular canals horizontal, both of normal and traumatic type.

1. Desch, H. E., *Manual of Malayan Timbers*, 1957.
2. Metcalfe, C. R. and Chalk, L., *Anatomy of the Dicotyledons*, Oxford, 1950, Vols. 1 and 2.
3. Moll, J. W. and Janssonius, H. B., *Mikrographie des Holzes der auf Java Vorkommenden Baumarten*, Leiden, 1914, 3.



FIGS. 1-4. Figs. 1-2. *Adenantheroxylon pavoninium* gen. et sp. nov. Fig. 1. Cross section of the fossil wood showing the vessel and parenchyma distribution,  $\times 30$ . Fig. 2. Tangential section of the fossil wood showing xylem rays,  $\times 90$ . Figs. 3-4. *Swintonioxylon hailakandiense* gen. et sp. nov. Fig. 3. Cross-section of the fossil wood showing the distribution of vessel and parenchyma,  $\times 30$ . Fig. 4. Tangential section of the fossil wood showing gum canals in the xylem rays,  $\times 40$ .

A detailed study and comparison with the modern woods shows that the fossil wood resembles most with the wood structure of *Swintonia floribunda*, Griff. Syn. *S. schwenckii* (Teysm. et Binnend.) Kurz of the family Anacardiaceae (Metcalfe and Chalk, 1950; Desch, 1957). Therefore, the fossil wood is being designated as *Swintonioxylon hailakandiense* gen. et sp. nov.

Birbal Sahni Institute of  
Palaeobotany,  
Lucknow (India), November 30, 1967.

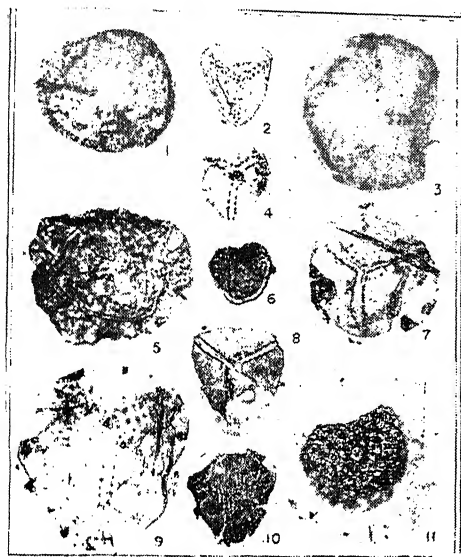
U. PRAKASH.  
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#### SPOROLOGICAL ANALYSIS OF THE PANCHET SERIES AND ITS BEARING ON THE PERMIAN-TRIASSIC TRANSITION\*

THE Panchet Series of the Raniganj Coalfield, West Bengal, has yielded a rich assemblage of microfossils which has been studied in detail. The only palynological study of the Panchet made so far is by Shrivastava and Pawde<sup>1</sup> who attempted to define the boundary between the Raniganj and Panchet in a borehole at Ondal



(Andal), West Bengal. The present study shows that Panchet mioflora consists predominantly of disaccate forms like *Striatites*, *Striatopodocarpites*, *Faunipollenites* and *Dis-triatites*. The pteridophytic spores like *Leiotriletes*, *Eupunctisporites*, *Cyclogranisporites* and *Verrucosisporites* are also well represented in the assemblage. In this respect the Panchet mioflora shows affinity to the mioflora of the Raniganj Stage. However, several genera such as *Tumoripollenites*, *Platysaccus*, *Cuneatisporites*, *Lahirites* and *Kosankeisporites* of the Raniganj Stage are conspicuously absent.



FIGS. 1-11. Figs. 1, 3, 11. *Triletes* sp.,  $\times 125$ . Figs. 2, 4 and 6-10. *Duosporites* sp.,  $\times 125$ . Fig. 5, Winged spore,  $\times 500$ .

The monosaccate spores *Virkkipollenites*, *Plicatipollenites* and *Potonieisporites* which form the main constituent of the Talohir and Karharbari flora show a gradual decline during succeeding stages and practically die out in the Panchet. Out of nearly 28 genera of the pteridophytic spores of the Raniganj Stage only seven are recorded in the Panchet. The monolet and monocolpate forms like *Vittatina* and *Ginkgocycadophytus* are rare and the forms *Wilwitschiapites* and *Gnetaceaepollenites* are absent in this assemblage.

Some megaspores have been recovered and they are represented by at least three genera namely, *Triletes*, *Duosporites* and (?) *Talchirella*. The occurrence of megaspores in the Panchet and their absence in the Raniganj Stage lend a distinct character to the Panchet mioflora.

Compared with the Lower Triassic of the world, the Panchet assemblage differs widely from the European and Canadian mioflora while it compares partly with the West Australian assemblage. Hennelly<sup>2</sup> laid emphasis on the presence of *Quadrissporites horridus* and *Virkkipollenites (Nuskoisporites) radiatus* in the basal Triassic of Sydney Basin above the characteristic *Lunatisporites* and *Dulhuntyispora* of the Upper Permian age. In India this fact loses its significance as *Quadrissporites* is known only from the Talchir State (Potonie and Lele).<sup>3</sup> Thus the Panchet mioflora from that of Australia.

The present study indicates that the prolific mioflora of the Raniganj Stage suffered a major decline during the Panchet, a fact which is in accordance with the megafossil history.

The authors are thankful to Shri M. V. A. Sastry for his guidance and helpful suggestions.

Central Palaeontological Lab., P. P. SATSANGI,  
Geological Survey of India, A. CHANDRA.  
27, Chowringhee Road, GOPAL SINGH.  
Calcutta-13, September 20, 1967.

\* Published with the kind permission of the Director-General, Geological Survey of India.

1. Srivastava, R. N. and Pawde, M. B., "Palynological study of Borehole R.O. 1(1), Ondal, West Bengal," *Rec. Geol. Surv. Ind.*, 1962, **91**, Pt. 2, 369.
2. Hennelly, J. P. F., "Spores and pollen from Permian, Triassic transition. N.S.W., Australia," *Proc. Linn. Soc. N.S.W., Australia*, 1958, **83**, 363.
3. Potonie, R. and Lele, K. M., "Studies in Talchir flora of India—*Spor. dispersæ* from the Talchir beds of South Rewa Gondwana Basin," *Palaeobotanist*, 1961, **8** (1-2), 222.

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REVIEWS AND NOTICES OF BOOKS

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Annual Review of Microbiology (Vol. 21). Edited by C. E. Clifton. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1967. Pp. viii + 729. Price: U.S.A. \$8.50; Elsewhere \$9.50.

Volume 21 of this well-known series contains the following articles: Prefatory Chapter: The Education of a Microbiologist; Some Reflections, by C. B. van Niel; Euglenida/Euglenophyta; Enrichment Cultures; Biology of Actinomycetes; Temperature Effects on Micro-organisms; Methane Fermentation; Survival of Bacteria; Tolerance; Cellular Commitments to Immune Responses; Unusual Vectors of Plant Viruses; Fatty Acid Synthesis and Metabolism in Micro-organisms; Colicins and Related Bacteriocins; Photosynthetic Bacteria; The Effects of Ionizing Radiation on Nucleic Acids of Bacteriophages and Bacterial Cells; Mechanisms of Nucleic Acid Synthesis; The Mechanism of Protein Synthesis; Structure and Function of Bacterial Cell Membranes; Salmonella O Antigens and Virulence; The Possible Role of Micro-organisms and Viruses in the Etiology of Chronic Degenerative Diseases of Man; Food-Borne Salmonellosis; Virus Leukemia in the Mouse; The Mammalian Cell as Differentiated Micro-organism; Episomes; Defences Against Biological Warfare; Other Reviews of Microbiological Interest.

C. V. R.

**Algebraic Theory of Particle Physics—Hadron Dynamics in Terms of Unitary Spin Currents.** By Yuval Ne'eman, Tel-Aviv University. (W. A. Benjamin, Inc., One Park Ave., New York), 1967. Pp. xvi + 334. Price: Cloth Edition \$10.00; Paperback Edition \$5.95.

This informal monograph crystallizes the theory of elementary particles which has developed since the discovery of unitary symmetry (or unitary spin) in 1961. The first book to give a comprehensive view of this new branch of particle physics theory based on use of the components of unitary spin as the main dynamical objects, it may be used as a text or supplement for graduate courses in elementary particle physics.

The titles of the chapters contained in this book are: Introduction; The Abstract Algebra

of Unitary Spin; The Role of Algebras in Quantum Mechanics; Unitary Symmetry; The Physical Algebra of Unitary Spin; Applying SU(3) to Hadron Electromagnetic and Weak Interactions; The Algebra of Scalar and Pseudoscalar Integrated Charges; The TOA of Space-Integrals of Current Components and Its ASA Subsets; An Algebra of Factorized Regge Residues; Search for the Hadron Spectrum-Generating Algebra; and Epilogue.

C. V. R.

**Problems of Modern Physics.** By H. A. Lorentz. (Dover Publications, Inc., New York), 1967. Pp. viii + 312. Price \$2.25.

The great Dutch physicist Hendrik Lorentz (1853–1928), winner of the Nobel Prize for his work on the Zeeman effect, was long at the very heart of the most important developments in understanding light, matter and relativity. He was also a distinguished teacher, who trained many of the most important European and American scientists of the generation that followed him.

In 1922, Lorentz was selected as a visiting scholar at the California Institute of Technology, where he delivered a series of semi-popular lectures. In these lectures, which were primarily non-mathematical and invoked the calculus only occasionally, Lorentz summed up verbally his lifetime understandings: light propagation, the Maxwell equations, experimental determination of the velocity of light, field equations of the electron theory, Rayleigh's formula, special relativity, quantum theory, the Zeeman effect, the General Theory and Einstein's field equations, Bohr's principle of correspondence, displacement of the spectrum, and many other important topics in modern physics.

Brought into final form in this book, these lectures remain a concise treatment of concepts that are still at the heart of physics.

C. V. R.

**Finite Deformation of an Elastic Solid.** By Francis D. Murnaghan. (Dover Publications, Inc., New York), 1967. Pp. ix + 140. Price \$1.85.

This Dover edition, first published in 1967, is an unabridged and unaltered republication



of the work originally published by John Wiley and Sons, Inc., in 1951.

The contents of this book are: Vectors and Matrices; The Specification of Strain; The Connection Between Stress and Strain; Isotropic Elastic Media; Non-Isotropic Elastic Media; Simple Shear and Tension; and Particular Problems.

C. V. R.

*Stream Flow—Measurements, Records and Their Uses.* By Nathan Clifford Grover and Arthur William Harrington. (Dover Publications, Inc., New York), 1966. Pp. xxiii + 363. Price \$ 2.25.

This Dover edition, first published in 1966, is an unabridged and unaltered republication of the second (1949) printing of the work originally published by John Wiley and Sons, Inc., in 1943. This edition also contains a new introduction by Ven Te Chow, University of Illinois, Urbana, Illinois.

This edition contains the following chapters: Precipitation and Runoff; Ground Water; Quality of Water; Physical Control of Rivers; Governmental and Legal Control of Rivers; Utilization of Rivers; Records of River Discharge and Their Utility; Methods and Instruments for Measuring and Recording Stream Flow; Functions and Characteristics of Gaging Stations; Establishment of Gaging Stations; Control Sections Installation of Gages; Structures from which Discharge Measurements are Made; Operation of Gaging Stations; Computing and Preparing Records for Publication; Analysis and Presentation of Stream-Flow Records for Specific Use; Governmental Publication of River Records; Special Reports; Organization in Field and Office; Co-ordination in Administration and Financing.

C. V. R.

*Introduction to Operations Research.* By F. S. Hillier and G. J. Lieberman. (Published by Holden-Day, Inc., 500 Sansome Street, San Francisco), 1967. Pp. 639. Price \$ 13.75.

Operations Research may be described, in the main, as the scientific approach to decision-making that involves the operations of organizational systems. Operations Research provides career opportunities and most of the American Universities offer courses in this field. This introductory text offers a comprehensive survey of the basic methodology and techniques of operations research. The text is organized into five parts. Part I, Methodology, gives a general introduction to the field. Part II,

Fundamentals, is devoted to probability theory, statistics, and mathematics. The remaining three parts are devoted to basic models and techniques in increasing order of difficulty. Thus Part III deals with Linear Programming, Network Analysis and Dynamic Programming; Part IV is devoted to Queueing Theory, Inventory Theory, Markov Chains and Their Applications, and finally, Part V, to advance topics in Linear Programming, Integer-Programming and Non-Linear Programming.

A. S. G.

*Inorganic Chemistry (Third Edition).* By C. W. Wood and A. K. Holliday. [Butterworth & Co. (Publishers, Ltd.), 88, Kingsway, London W.C. 2], 1967. Pp. 421. Price 25 sh.

This text-book on inorganic chemistry, originally designed to meet the requirements of the G. C. E. Advanced and Scholarship level examination in chemistry, can also be recommended as a suitable text-book in inorganic chemistry for the one-year pre-University science students proceeding to a degree course in science or medicine. The treatment is systematic and modern. The chemistry of the elements and their compounds has been considered from the view-point of the periodic classification. The first two editions had been very popular, and there is no doubt that the present third edition will also receive ready acceptance. The third edition contains a number of changes and additions, especially the chapter on valency has been brought more up-to-date.

A. S. G.

*A Course in Modern Techniques of Organic Chemistry (Second Edition).* By J. A. Elvidge and P. G. Sammes. (Butterworths Publications), 1967. Pp. 315.

The first edition of this book was published in 1955 in accordance with a new course in organic chemistry introduced at the Imperial College of Science and Technology, London. The course itself was designed to fill the gap that existed then (and exists even now in many affiliated colleges of Universities) between the experimental graduate training provided in the college and the requirements of the research worker in organic chemistry. The Imperial College course had its impact outside in England, and also elsewhere in other countries. The demand for this text incorporating modern techniques in graduate organic chemistry practical training continued to grow and the result is this welcome second edition of the text.

The second edition has been extensively revised and enlarged. The thirty-five chapters in the book are divided into three sections, namely, Techniques of Separation and Purification; Special Reaction Techniques; Techniques of Quantitative Analysis and Allied Physical Measurements. Methods of operations which a trained organic chemist should be familiar with and able to perform for himself are described. Basic principles are illustrated, and well-tried instructions are provided.

It is an extremely useful book to help design a modern-oriented laboratory course in organic chemistry.  
A. S. G.

**Lipid Chromatographic Analysis (Vol. I).**  
Edited by Guido V. Marinette. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016), 1967. Pp. 537. Price \$23.50.

The application of chromatographic technique to the analysis of lipids is of recent origin. Fifteen years ago, for example, there was no convenient method of separating, detecting and analysing, on both a macro and micro scale, the various major phosphatides from biological sources. Although paper chromatography was readily available for the analysis of amino-acids and sugars, it could not be applied in the lipid field because the problem yet remained of developing suitable solvent systems for the effective resolution of lipid components. It was only a decade ago that solvent systems for resolving phosphatides on silicic-acid-impregnated filter-paper were developed. The use of chloroform-methanol solvents, and diisobutylketone-acetic acid-water system came into vogue for the separation and analysis of intact phosphatides and glycolipids on a micro level. The development of gas-liquid chromatography opened a new dimension in lipid research allowing the study of the fatty acids of the various lipid classes with methyl esters. The coupling of gas chromatography with other physical methods such as mass spectroscopy, infrared spectroscopy, nuclear magnetic resonance, etc., is already showing promise. The subject is vast and is rapidly growing.

The two-volume publication to contain a comprehensive coverage of chromatographic methods in lipid research which are in practice, is the first attempt of its kind and it will provide an indispensable reference work

to research workers in this field. Twenty-two authors, each one with considerable experience in the proven technique of his choice, have contributed to the fourteen chapters of the first volume.  
A. S. G.

#### Books Received

**Introduction to Operations Research.** By F. S. Hillier and G. J. Lieberman. (Holden-Day, Inc., San Francisco), 1967. Pp. x + 639. Price \$13.75.

**Inorganic Chemistry an Intermediate Text.** By C. W. Wood and A. K. Holliday. (Butterworth and Co., London W.C. 2), 1967. Pp. xi + 421. Price 25 sh.

**Communication in Science Documentation and Automation.** Edited by Anthony De Reuck, J. Knight. (J. and A. Churchill Ltd., London W. 1), 1967. Pp. xi + 273. Price 60 sh.

#### ANNOUNCEMENTS

##### Award of Research Degree

M. S. University of Baroda has awarded the Ph.D. degree in Physics and Chemistry to Messrs. K. Jacob Rajan and Vilas Shivram Salvi respectively.

Osmania University has awarded the Ph.D. degree in Physics to Shri V. Venkatachala-pathi; Ph.D. degree in Biochemistry to Shri M. Mohan Ram; Ph.D. degree in Zoology to Shri N. Venkat Rao; Ph.D. degree in Botany to Shri Nallapparaju Subba Raju.

##### UNESCO International Cell Research Organization

In the series of ICRO/UNESCO training courses on recent techniques in Cell Research, a South-East Asian regional course on the *Genetics and Physiology of Bacterial Viruses* will be held from June 24 to July 27, 1968 at the Pharmacology Laboratory, Indian Institute of Science, Bangalore-12, India.

The course will include Fundamental Experiments, Demonstrations, Seminars and Group Discussions.

The number of participants will be limited to sixteen. Only post-graduate students in the fields of physics, chemistry and biology (including biochemistry and microbiology) will be accepted.

Applications (and enquiries) should be sent to: Pharmacology Laboratory, Indian Institute of Science, Bangalore-12, India. Deadline for applications: March 1, 1968.

# NON-FATTY COMPONENTS OF THE SEEDS OF *SALVADORA OLEOIDES*

G. R. CHOPRA, A. C. JAIN AND T. R. SESHADRI

Department of Chemistry, University of Delhi

*SALVADORA OLEOIDES* is a small ever-green tree found in many parts of North India. Its Indian names are "Chhota Pilu" and "Khakan". Its fruits are small berries and contain seeds covered with white, sweet and pungent pulp. The seeds are known to be rich in oil (~40–50%).<sup>1</sup> The oil expressed in country ghanies is considered inedible and does not find any worthwhile use commensurate with its potential availability. Since it resembles coconut oil and contains a large percentage of lauric acid (~47.2%), it could be used for soap-making but the undesirable colour and odour of the oil seem to prevent its full exploitation. With a view to know the minor components of the seeds and pulp, some of which may impart the undesirable character to the oil, the present investigation has been undertaken.

Patel, Sudborough and co-workers<sup>2</sup> were the first to study the seed oil. They noted that the oil expressed in country ghanies differs from the oil extracted from the seeds by ether; the former has a pungent odour and gives benzyl isothiocyanate as the steam volatile product in 1.5% yield but the latter is free from this characteristic smell and does not contain nitrogen and sulphur in appreciable amounts. In order to study the non-fatty components, they extracted the expressed oil with 92% alcohol, removed the alcohol from the extract, steam-distilled the residue to remove benzyl isothiocyanate and finally saponified the remaining liquid. From the non-saponifiable part, they obtained two crystalline compounds, viz., sitosterol and sym. dibenzyl thiourea. More recently, Awasthi and Mitra<sup>3</sup> have examined the alcoholic extractive of the coarsely broken fruits. They fractionated the above extract (~10% of the fruits) into four different fractions. (a) light petroleum, (b) ether, (c) ethyl acetate, and (d) water soluble. The light petroleum fraction on concentration yielded crystalline  $\beta$ -D-glucoside of  $\beta$ -sitosterol. The mother liquor on steam distillation gave benzyl isothiocyanate as volatile component and the residue on saponification gave five substances in the unsaponifiable part. One of them was identified as

$\beta$ -sitosterol and two others considered to be *n*-octacosanol (m.p. 84°), and tetracosane (m.p. 49°) and the remaining two [ $C_{18}H_{36}O_3$ , m.p. 171° and sterol (in traces), m.p. 148°] could not be identified. The ether and ethyl acetate extracts yielded an optically active compound, m.p. 161° containing N and S besides the above-mentioned  $\beta$ -sitosterol glucoside and the compound, m.p. 171°. The aqueous fraction on acid hydrolysis gave quercetin, glucose and potassium sulphate.

In our investigation, a different procedure has been adopted; the pulp of the fruits were separated from the seeds and the parts examined separately. This procedure is expected to avoid enzymic hydrolysis of seed components. The fruits\* (3.5 kg.) were depulped by scrubbing with water and the clean seeds obtained. The water suspension of the pulp was thoroughly shaken with ether and filtered. The ether layer gave on concentration a small amount of  $\beta$ -sitosterol, m.p. and mixed m.p. 136–37°,  $[\alpha]_D^{25} CHCl_3$  –39.3°, comparative t.l.c. (solvents A, B and C†, spray 1) showing single spot, acetate, m.p. 132–33°,  $[\alpha]_D^{25} CHCl_3$  –40°. The aqueous layer was examined by comparative paper chromatography (descending) (solvents D and E; spray 5) showing the presence of glucose, fructose and sucrose.

The air-dried seeds were crushed and extracted successively with (1) boiling petroleum ether, (2) cold ether, (3) boiling methanol and (4) 70% boiling aqueous methanol.

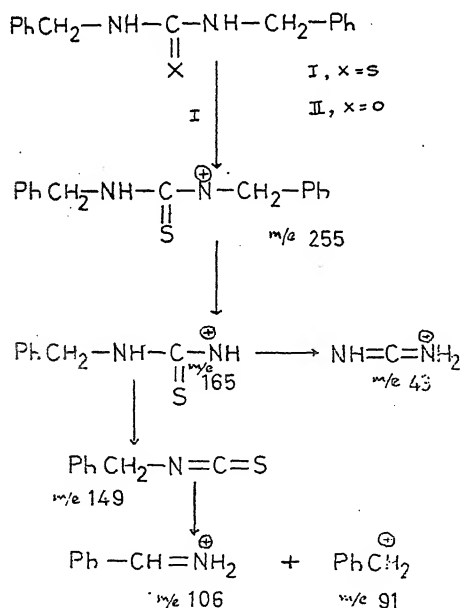
\* Supplied by Sarvodaya Kendra, Khemal, P.O. Rani, Rajasthan.

† *Solvent systems for chromatography*: (A) Benzene, (B) Benzene-chloroform (1:1), (C) Ethyl acetate: Petroleum ether (1:9), (D) *n*-Butanol: acetic acid: water (4:1:5) (upper layer), (E) *n*-Butanol: pyridine: water: benzene (5:3:3:1) (upper layer), (F) Chloroform, (G) Ethyl formate: formic acid: toluene (20:5:25), (H) Chloroform: formic acid: ethyl acetate (25:5:20), (I) Ethyl acetate saturated with water, (J) Phenol saturated with water (K) 15% acetic acid, (L) Benzene: ethyl acetate: formic acid (10:7:4), (M) 60% aqueous acetic acid, (N) Butanol: ethanol: water (4:1:4), (O) Butanol: pyridine: water (6:4:3), (P) Ethanol: liquor ammonia (99:1), (Q) Methanol: 6N HCl (70:30).

*Sprays*: (1) 10% aqueous  $H_2SO_4$ , (2) Alcoholic  $FeCl_3$ , (3) Bromophenol blue, (4) Ammoniacal  $AgNO_3$ , (5) Aniline hydrogen phthalate, (6) Picryl chloride.

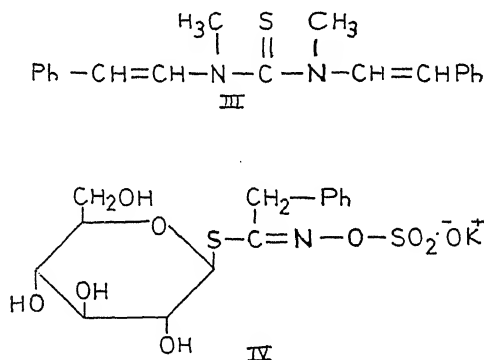
The first two fractions being identical on T.L.C. (solvents A, B and F, spray 1) were mixed together and freed from solvents giving the major extractive (35% yield). It was mostly oil, did not yield non-fatty components directly and hence was saponified. The non-saponifiable matter (0.9% of the oil) was separated into three fractions: (a) light petroleum insoluble at room temperature, (b) light petroleum insoluble at 5–10° and (c) light petroleum soluble and all these fractions were separately chromatographed over neutral alumina.

Fraction (a) yielded two crystalline compounds on elution with benzene. The first (270 mg.) eluted in the beginning was identified as sym. dibenzyl thiourea<sup>4</sup> (I), m.p. 147–148°,  $\lambda_{\text{max.}}^{\text{MeOH}}$  242 (log  $\epsilon$  4.37), T.L.C. (solvent F, spray 1) showed one spot (Found: C, 70.7; H, 6.8; N, 10.9, S, 11.9%; calculated for  $\text{C}_{15}\text{H}_{16}\text{N}_2\text{S}$ : C, 70.3; H, 6.3; N, 10.9; S, 12.5%). Its mass spectrum exhibits characteristic peaks at  $m/e$  165, 149, 106, 91 and 43 besides the molecular ion peak at  $m/e$  255. The fragmentation pattern is shown below.



The second compound (250 mg.) eluted in the later fractions was identified as sym. dibenzyl urea (II), m.p. and m.m.p. with synthetic compound<sup>5</sup> 166–68°; comparative T.L.C. (solvent F, spray 1) identical (Found: C, 74.9; H, 6.9; N, 12.1; O, 6.7%. Calculated

for  $\text{C}_{15}\text{H}_{16}\text{N}_2\text{O}$ : C, 75.0; H, 6.7; N, 11.7; O, 6.6%). Its U.V. spectrum in methanol is noteworthy; it gave six clear peaks in the region 246–266  $m\mu$ , all of weak intensity ( $\sim \log \epsilon$  2.62). The synthetic sample of sym. dibenzyl urea also showed the same spectrum. Fraction (b) on chromatography and elution with light petroleum-benzene mixture (1:1) gave a solid which crystallised from benzene as colourless crystals (0.18 g.), m.p. 180–82°,  $\lambda_{\text{max.}}$  280  $m\mu$  (log  $\epsilon$ , 4.1), T.L.C. (solvent A, spray 1) showed one spot. It has the special property of absorbing and retaining water (Found in a sample dried in vac. at 100°: C, 72.4; H, 6.5; N, 8.9; S, 10.6%.  $\text{C}_{19}\text{H}_{20}\text{N}_2\text{S} \cdot \frac{1}{2}\text{H}_2\text{O}$  requires C, 71.9; H, 6.6; N, 8.8; S, 10.1%). The n.m.r. spectrum in  $\text{CDCl}_3$  using 60 m.c. spectrometer showed three singlets:  $\tau$  2.65 (10 aromatic protons), 4.52 (4 vinylic protons) and 8.06 (6 methyl protons); there was no proton attached to either nitrogen or sulphur. Based on these data, a tentative structure (III) is proposed for it.



The light petroleum soluble fraction (c) was subjected to chromatography over neutral  $\text{Al}_2\text{O}_3$ . The first eluant with light petroleum yielded first a small amount of carotenoids,  $\lambda_{\text{max.}}$  (in hexane) 466, 450  $m\mu$  and (in  $\text{CHCl}_3$ ) 475, 440  $m\mu$ , followed by a colourless crystalline solid, m.p. 54° which seems to be largely a mixture of higher hydrocarbons (Found: C, 83.17; H, 14.03). The next eluant with benzene-light petroleum mixture gave another colourless solid, m.p. 83–84° and it appears to be a mixture of higher alcohols (Found: C, 80.72; H, 12.98). Further elution with benzene yielded  $\beta$ -sitosterol in a large amount (6.9 g.) constituting about 60% of the non-saponifiable matter.

The methanolic extract of the seeds yielded small amounts of two compounds; one (5 mg.) was identified as quercetin by comparative paper chromatography (solvents D, I, J, K, spray 2) and T.L.C. (solvents G, H and L, spray 2) and by U.V. data,  $\lambda_{\text{max}}^{\text{EtOH}}$ : 258, 375 m $\mu$  the other as 3-rutinoside of quercetin (or rutin); m.p. and m.m.p. 185-90°;  $\lambda_{\text{max}}^{\text{EtOH}}$ : 258, 310, 361 m $\mu$ ;  $R_f$  values on paper chromatography (solvents D and M; spray 2) identical with those of authentic sample. Rutin was further confirmed by identifying acid hydrolysis products as quercetin, D-glucose and L-rhamnose by comparative paper chromatography solvents D and E, spray 5).

The 70% aqueous methanolic extract on concentration and extraction with ether gave a further small amount of quercetin, whereas the aqueous part on paper chromatography (solvents N and O, spray 4) showed the presence of one glucosinolate (for general procedure; see Ref. 6). It was identified as glucotropaeolin<sup>7</sup> (IV) by hydrolysis with 20% aq. HCl when phenyl acetic acid was isolated as colourless crystals, m.p. and m.m.p. 75-76°; paper chromatography (solvent P, spray 3) showed the same  $R_f$  value as authentic sample. D-Glucose and hydroxylamine hydrochloride were identified by comparative paper chromatography using in the latter case the solvent system (Q) and spray (6) and the presence of potassium and sulphate ions was shown by usual qualitative tests.

It is difficult to compare our work with those of previous workers because the materials and the method used are not strictly the same. In our experiments, we have avoided the hydrolysis of the thio-glucoside, glucotropaeolin (IV) with the result that its presence could be established in aqueous methanolic extract of the seeds. This may explain why we did not get benzyl isothiocyanate. The findings of Awasthi and Mitra are difficult to interpret; for example, the substance m.p. 161° is optically active, has the molecular formula of dibenzyl thiourea and the U.V. similar to dibenzyl urea. Possibly they were dealing with mixtures. Similarly the identification of octacosanol and tetracosane is also doubtful;

generally such compounds occur as mixtures and m.p. and analysis are not enough criteria for their purity and structures.

Sym. dibenzyl urea and sym. dibenzyl thio-urea seem to be normal genuine components of the seeds and not artefacts because the oil before saponification gave no tests for either isothiocyanate or glucotropaeolin. They might have arisen from the thioglucoside glucotropaeolin by normal metabolism in the seeds. In the alternative, they may arise from benzylamine (moringin) which has not been detected in these seeds but is known to occur in the bark of *Moringa pterygosperma*<sup>8,9</sup> and *Moringa oleifera*.<sup>9</sup> This amine which is probably derived from phenyl glycine by decarboxylation can condense with benzyl isothiocyanate to give dibenzyl thiourea. The occurrence of dibenzyl thiourea has also been noted in the bark of *Crataeva roxburghii*.<sup>10</sup>

From the above study, it may be concluded that the minor components of the seeds which make the oil non-edible are probably dibenzyl thiourea and dibenzyl urea and the thioglucoside whose decomposition products may also be present when the oil is extracted by unsuitable methods.

1. (a) Kirtikar, K. R. and Basu, B. D., *Indian Medicinal Plants*, Allahabad, 1935, 1536 42. (b) Kane, J. G., *Sonderdruck Aus Fettesäuren Austrichemische Die Ernährungsindustrie*, 1965, **67**, 396.
2. Patel, C. K., Iyer, S. N., Sudborough, J. J. and Watson, H. E., *J. Ind. Inst. Sci. Bangalore*, 1926, **9A**, 117.
3. Awasthi, Y. C. and Mitra, C. R., *Ind. Oil Seeds J.*, 1964, **8**, 289; *Chem. Abst.*, 1965, **62**, 9458.
4. Strakosch, J., *Ber.*, 1872, **5**, 692.
5. Mistry, S. M. and Guha, P. C., *J. Ind. Chem. Soc.*, 1930, **7**, 793.
6. Kjaer, A. and Thomson, H., *Phytochem.*, 1963, **2**, 29.
7. Schultz, O. E. and Wagner, W., *Arch. Pharm.*, 1955, **288**, 525.
8. Ghosh, S., Chopra, R. N. and Dutt, A., *Ind. J. Med. Res.*, 1935, **22**, 785.
9. Chakravarti, R. N., *Bull. Calcutta School Trop. Med.*, 1955, **3**, 162; *C.A.*, 1956, **50**, 16891.
10. --, *Chem. Abst.*, 1952, **46**, 3221.

## IMPACT OF LIQUID QUENCHING ON ALUMINIUM-SILVER ALLOYS

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## INTRODUCTION

SEVERAL metastable and new intermediate phases have been detected in binary alloys quenched from the melt by the Duwez technique of liquid quenching,<sup>1</sup> also referred to as "Splat Cooling", which produces cooling rates of the order of  $10^6$ – $10^8$  degrees C/sec.<sup>2</sup> Some alloys have been found to exhibit amorphous solidification under such drastic rates of cooling. In many binary alloys a striking extension of the limits of solid solubility of terminal solid solutions has also been reported. The many interesting results obtained by this technique have been reviewed recently.<sup>3,4</sup>

The present work deals with the influence of liquid quenching on the solid solubility of silver in aluminium and on the constitution of two-phase alloys on the aluminium-rich side of the aluminium-silver system. The equilibrium diagram for the aluminium-silver system is well established (Fig. 1) and shows the

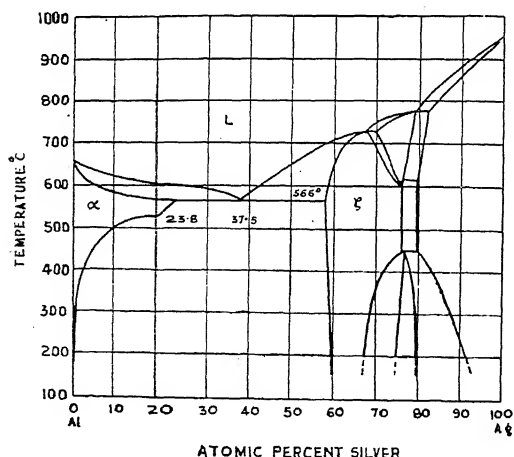


FIG. 1. Aluminium-silver equilibrium diagram.

existence of three intermediate phases in addition to the two face-centred cubic (f.c.c.) terminal solid solutions.<sup>5</sup> The lattice parameters of silver solid solutions have been found to decrease linearly with increasing amounts of aluminium in solution. The variation of lattice parameters of aluminium solid solutions has, however, been controversial. Earlier investigators<sup>6</sup> have stressed the importance of quenching from high temperatures at a rapid rate to prevent the separation of the

hexagonal close-packed (h.c.p.) zeta (ζ) phase in alloys containing more than 10 atomic % silver in solution. The effect of liquid quenching on the structure of ζ phase has also been investigated in the present study.

## EXPERIMENTAL PROCEDURE

Thirteen alloys (Table I) prepared from aluminium of 99.999+ % purity and silver of 99.95+ % purity and covering the entire range of α, α+ζ and ζ fields in the aluminium-silver system (Fig. 1), were investigated. Weighed quantities of the elements were melted in graphite crucibles by induction heating under argon atmosphere. The slugs were remelted under argon and cast into wires by sucking the liquid up into preheated 1mm. dia. quartz tubing and quenching into water.

TABLE I

Estimated distribution of phases at room temperature in aluminium-silver alloys quenched from the melt

At % Silver	Observed intensities of X-ray Reflections	
	α (f.c.c.)	ζ (h.c.p.)
5	vs	—
10	vs	—
15	vs	—
20	vs	—
25	vs	—
30	vs	vw
35	vs	w
40	s	m
45	ms	ms
50	w	s
55	vw	vs
60	—	vs
65	—	vs

vs=very strong; s=strong; ms=medium strong;  
m=medium; w=weak; vw=very weak.

The principle of liquid quenching has been described earlier.<sup>1</sup> Essentially it consists of loading 50–100 mg. of the alloy wire into a graphite nozzle and quickly heating it by induction to a temperature about 50 degrees C above the liquidus temperature for each alloy, under an atmosphere of argon. The molten alloy is then ejected by a blast of helium on to a copper sheet held on the inner periphery of a rotating wheel.

The product of liquid quenching in the present work was generally an ellipsoidal foil with irregular edges, of an average length of 2–4 cms. and a width of 0.5–1.0 cm. The

thickness varied from less than a micron at the edge to a maximum of 15 microns at the center of the foil. These foils were examined with or without the substrate in a Philips X-ray Diffractometer. Debye-Scherrer patterns were also obtained by sticking the alloy flakes on to a quartz fibre with cleavance and mounting the assembly in a Philips 114.6 mm. dia. camera. Filtered  $\text{Cu K}\alpha$  radiation ( $\lambda\text{CuK}\alpha_1$  1.5405 Å) was used to obtain the diffraction patterns at room temperature. Attention was mainly focused on the high angle (422) reflection in order to follow the change in lattice parameter of the aluminium solid solution with increasing amounts of silver in solution. This reflection was chosen because of its high Bragg angle, good intensity and clear resolution of  $a_1$  and  $a_2$ .

#### EXPERIMENTAL RESULTS

Table I gives the relative intensity of X-ray reflections from the  $\alpha$  (f.c.c.) and  $\zeta$  (h.c.p.) phases in stabilised liquid-quenched aluminium-silver alloys. The as-quenched alloys were observed to change at room temperature with regard to the proportion of phases in two-phase alloys and were generally stabilised after a short time. There was no evidence for the occurrence of any new phase in the composition range investigated.

The values of lattice parameters of the aluminium solid solutions were calculated from the (422) reflections after separating the  $a_1$  and  $a_2$  components by the method due to Anantharaman and Christian<sup>7</sup> and are plotted as a function of the atomic percentage of silver in Fig. 2 along with the results of some earlier investigators.

The  $\zeta$  phase obtained on quenching the 65 at.% silver-aluminium alloy had an axial ratio of 1.608 while the corresponding annealed alloy gave a value of 1.600. The axial ratios were arrived at by employing the method due to Otte and Esquivel.<sup>8</sup>

#### DISCUSSION OF RESULTS

As pointed out earlier,<sup>6</sup> conventional methods of quenching seem to fail to retain the super-saturated aluminium solid solution beyond 10 at.% silver in the aluminium-silver system. The quenched product generally consists of two phases. Fukano and Ogawa<sup>9</sup> have reported that it is possible to retain an aluminium solid solution with 20 at.% silver by quenching evaporated films of about 800 Å thickness on rock salt heated to 440 degrees C. The data of Table I clearly establish the efficacy of liquid quenching in retaining aluminium solid solutions containing upto, if not more than,

25 at.% silver. The maximum limit of solid solubility according to the equilibrium diagram (Fig. 1) is exceeded, although there is no spectacular extension of solid solubility due to splat cooling as in some other binary systems.<sup>3,4</sup>

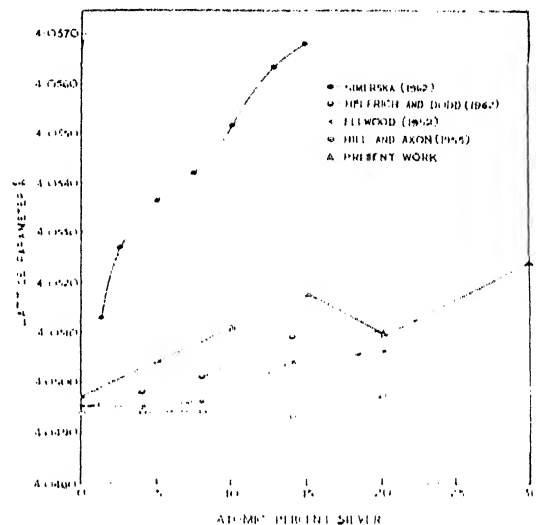


FIG. 2. Lattice parameters of aluminium-rich aluminium-silver solid solutions.

The X-ray diffraction data on lattice spacings of aluminium-silver solid solutions have recently been summarised by Pearson.<sup>10</sup> According to Ellwood,<sup>11</sup> the lattice parameter remains unaltered upto 6 at.% silver and shows a rapid increase between 6 and 14 at.% silver. The results of Hefrich and Dodd<sup>12</sup> agree in form with those of Ellwood. Hill and Axon<sup>6</sup> have reported an initial slight decrease in the lattice parameter. The high temperature data of Simerska<sup>13</sup> when reduced to room temperature show an irregular and rapid increase in the lattice parameter with increasing additions of silver. Guljaev and Trusova<sup>14</sup> have also reported a rapid increase. The lattice parameters determined in the present work from the (422) reflections of liquid-quenched aluminium-silver alloys show an increase upto about 30 at.% silver with an anomaly at 20 at.% silver. It is interesting to note that this anomaly corresponds to that observed in the solvus line<sup>15</sup> in the aluminium-silver equilibrium diagram (Fig. 1). The sudden drop in the lattice parameter at 20 at.% silver as well as the anomaly in solid solution data is not readily understood and may be related to electronic effects and the formation of a defect structure. A similar trend in the variation of lattice parameter has been obtained in this investigation from a study of the (331) reflections also.

The structure of the  $\xi$  phase has been investigated earlier. The  $\xi$  phase has an h.c.p. structure and the lattice spacings are found to vary with composition. Westgren and Bradley<sup>16</sup> found that the axial ratio ( $c/a$ ) varies from 1.625 at 73 at.% silver to 1.588 at 57 at.% silver. Massalski and Cockayne<sup>17</sup> have observed that the basal lattice spacing ( $a$ ) varies linearly with the electron concentration per atom, but the curves for the ' $c$ ' spacing and the axial ratio show a distinct change of slope between the electron concentration values of 1.62 and 1.63. In the present investigation the axial ratio of the phase in an alloy having 65 at.% silver was measured both in the annealed state and after liquid quenching. In the annealed state the axial ratio was found to be 1.600 while it rose to 1.608 after liquid quenching. This increase suggests that the axial ratio may be a function of temperature in addition to its being composition-dependent. Further work is in progress to study the variation of axial ratio with temperature. It is interesting to note in this connection that the  $\xi$  phase precipitating from vapour-quenched aluminium-rich solid solutions also exhibits a decrease in axial ratio with ageing.<sup>6</sup> A similar variation of axial ratio might occur in liquid-quenched alloys and needs further investigation.

## ACKNOWLEDGEMENT

The authors are grateful to Professor Pol Duwez, California Institute of Technology, Pasadena, U.S.A., in whose laboratories part of the experimental work was carried out.

1. Pol Duwez and Willens, R. H., *Trans. Met. Soc. AIME*, 1963, **227**, 362.
2. Predecki, P., Mullendore, A. W. and Grant, N. J., *Ibid.*, 1965, **233**, 1581.
3. Anantharaman, T. R. and Ramachandra Rao, P., *Eastern Metals Review*, 1967, **19**, 141.
4. Pol Duwez, *Progress in Solid State Chemistry*, 1966, **3**, 377.
5. Hansen, M., *Constitution of Binary Alloys*, McGraw-Hill Book Company, Inc., New York, 1958.
6. Hill, R. B. and Axon, H. J., *Research*, 1955, **8**, 52.
7. Anantharaman, T. R. and Christian, J. W., *Brit. Jour. Appl. Phys.* 1953, **4**, 155.
8. Otte, H. M. and Esquivel, A. L., *Trans. Met. Soc., AIME*, 1965, **233**, 1276.
9. Fukano, Y. and Ogawa, S., *Acta Cryst.*, 1956, **9**, 971.
10. Pearson, W. B., *Handbook of the Lattice Spacings and Structure of Metals and Alloys*, Pergamon Press, New York, 1967.
11. Ellwood, E. C., *Jour. Inst. Metals*, 1953, **80**, 605.
12. Helfrich, W. J. and Dodd, R. A., *Trans. Met. Soc., AIME*, 1962, **224**, 757.
13. Simerska, M., *Czechosl. J. Phys.*, 1962, **12**, 54.
14. Guljaev, A. P. and Trusova, E. F., *Z. Tekh. Fiz., SSSR*, 1950, **20**, 66.
15. Raynor, G. V. and Wakeman, D. W., *Phil. Mag.*, 1949, **40**, 404.
16. Westgren, W. and Bradley, A. J., *Ibid.*, 1928, **6**, 280.
17. Massalski, T. B. and Cockayne, B., *Acta Met.*, 1959, **7**, 762.

## SIGNIFICANCE OF FISSURES AND CRACKS DEVELOPED IN EARTHQUAKE AFFECTED AREA AROUND KOYANANAGAR, MAHARASHTRA

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### INTRODUCTION

**F**IVE major earthquakes rocked the region around Koyananagar (17° 24' N: 73° 45' E—Approx.) within a period of four months and the shock of the 11th December, 1967 was the most severe (magnitude 7.5-Richter scale) and was felt all over the country. Some fore-shocks and hundreds of after-shocks which are still being received in the Koyananagar area, are recorded. According to the reports of the meteorological observatory, Poona, the epicentres of all these earthquakes were within an area of about 10 km. radius around Koyananagar where the hydraulic dam on river Koyana is situated. Geologically, the area in the region is occupied by the basic rocks of the Deccan Trap formation. Lateritic caps covering the hilly regions is a common feature and the soil in this area is also lateritic.

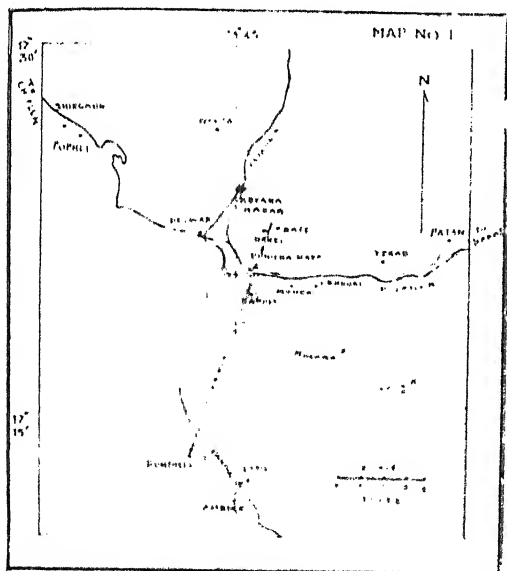
### FISSURES AND CRACKS

Mainly two types of fissures and cracks were seen to have developed in this region after the earthquake of the 11th December 1967. The first type of fissures and gapings are developed in soil and on steep slopes of high hills and there is no doubt that these have been produced due to the slumping of soil and subsoil along the slopes. It was also recorded that some instances of land slides have taken place under such conditions and it is very remarkable that the majority of the land slides were observed in a zone trending N 20° E-S 20° W along Rundhiv-Lotiv, Kadoli, Donicha Wada, Nanel, Baje, etc. (see Map 1).

The second type of fissures, which were also seen to have developed in soil only, have altogether different characteristics. These cracks typically show a right handed en echelon



alignment in a restricted narrow zone (about 20 meters in width) running for about 40 km. in a direction N 20° E S 20° W along Bajel, Nanel, Kadoli, Donicha Wada and extending upto Rundhiv towards south. The individual fissures hardly extend to 100 meters in length and their width is also very small and not exceeding over 20 cm. These gapings do not penetrate very much in depth and are confined to soil and subsoil only. It is very striking that these fissures show a strong preferred orientation and the maximum of them trend nearly N 15° W S 15° E. Figure 1 shows the frequency distribution of the orientation of the various fissures belonging to this type and which are confined to the zone mentioned above.



MAP 1. Location map of the area showing the epicentral zone along Fandhiv Kadoli Nanel, etc.

In this area an interesting observation was made by the author near Nanel where fixed objects like 'Tahin Vrindavan' and supporting stones for wooden props of the 'Sukun-Mahankal' temple have been rotated in an anticlockwise manner by about 10 to 20 degrees (amount of rotation varying in individual cases).

An experiment was performed in which two wooden blocks of identical dimensions were kept close to each other (sides in contact) and were covered with damp red soil. A horizontal thrust was applied by means of a hammer to the block on the right-hand side (thrust direction shown by arrow, see Photos 1-4) and it was made to move forward with respect to the block on the left-hand side and still keeping

in contact with it. Cracks making an angle of about 30 to 40 degrees with the direction of the thrust and showing an en echelon arrangement were developed.

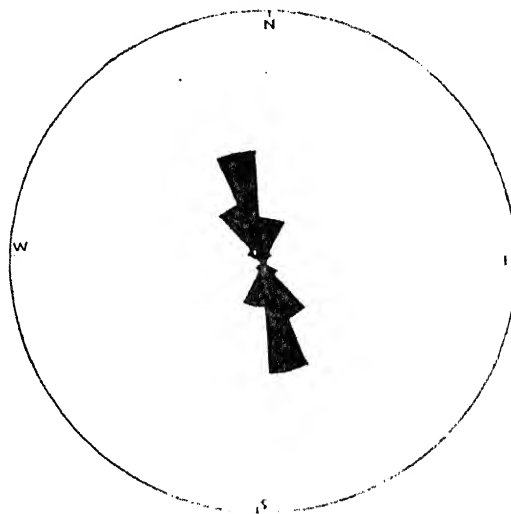


FIG. 1. Rose diagram showing the frequency distribution of the fissures of the second type in the epicentral zone along Fandhiv Kadoli Donicha Wada Nanel, etc. (Radius = 100, ...)

#### Discussion

The experimental results mentioned above are quite consistent with the theoretical proposition about shear and tension. If we assume that there is a movement of block A in a forward direction with respect to the block B (Fig. 2), tension is developed along the line P-Q and cracks would develop across it. The angle between the direction of the movement and the individual cracks will depend upon various factors such as the physical properties of the material involved, amount of thrust and the amount of vertical displacement, if any.

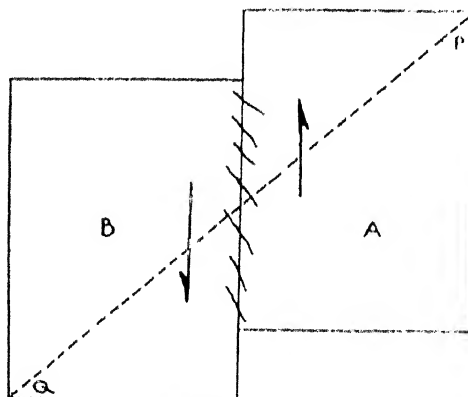
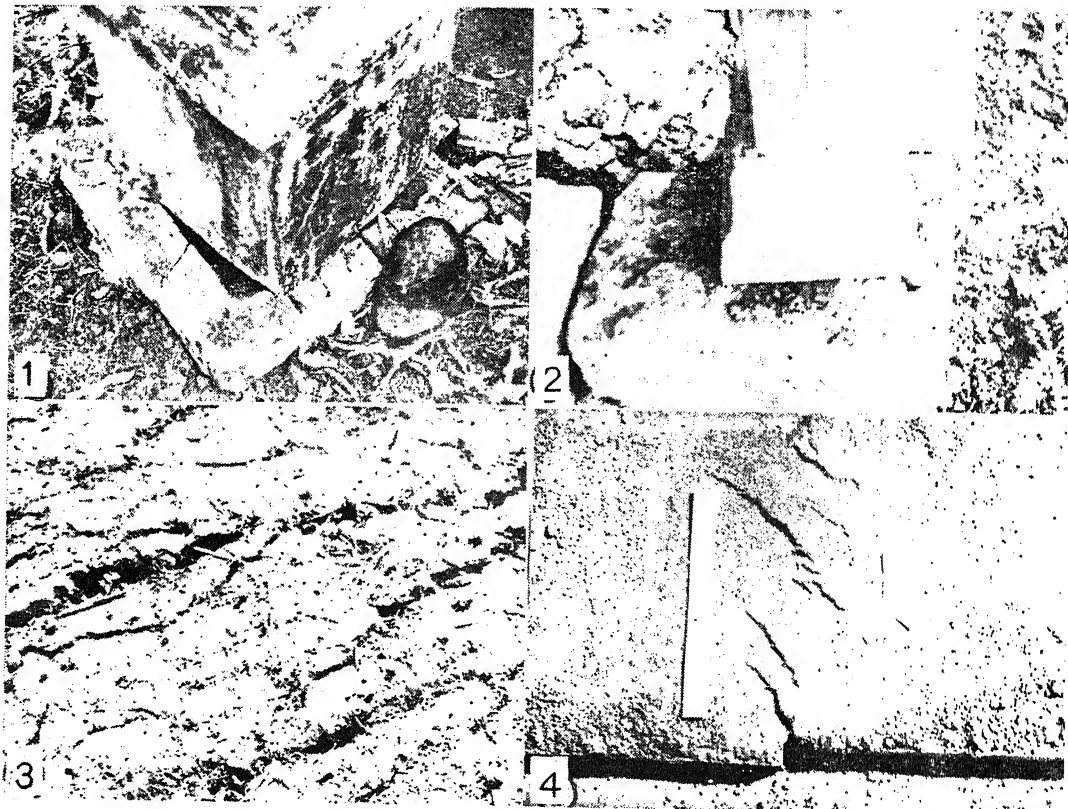


FIG. 2. Diagram illustrating shear and tension and development of cracks.

It is therefore quite probable that the zone of fissures along Kadoli, Donicha Wada, Nanel, Baje, etc., running in a direction N 20° E-S 20° W is a fault zone (a shear zone), and there is a nearly north-south movement of the blocks lying on either side of this zone. No evidence suggesting a vertical displacement was recorded and hence it appears more probable that the cause of the earthquake is a wrench fault in which the eastern block has moved

falls within an area bounded by an ellipse whose major axis runs in an almost east-west direction from Shirgaon to Yerad. It is therefore possible that the area around Koyananagar has acted like a central block lying between the two epicentral zones and has relatively moved towards south, the movement on the eastern side being the major one. There is ample evidence in support of the above generalisations and the second type of fissures



PHOTOS 1-4. Photo 1. Photo showing rotation of 'Tulshi Vrindavan' in an anticlockwise direction near Nanel (40 × 40 × 60 cm.). Photo 2. Photo showing anticlockwise rotation of the supporting stone for the prop of the north-east corner of the temple of Sukai-Mahankal near Nanel (Ball-pen placed for scale). Photo 3. Photo showing fissures of the second type in soil near Donicha Wada (Ball pen used for scale). Photo 4. Photo showing cracks developed in soil under experimental conditions. Arrow shows the direction of the horizontal thrust.

relatively towards north without involving any appreciable vertical movement.

There are reports of development of similar cracks (of second type) in the area between Pophli and Chiplun and also near Deshmukhwadi. This brings out another probability that there are two epicentral zones, one along Kadoli, Donicha Wada, etc. and the other lying to the west of Koyananagar. R. N. Joshi has studied the extent of damage in this area and finds that the maximum affected region

and the rotation of the fixed objects like 'Tulshi-Vrindavan', etc., are particularly characteristic.

The author expresses his thanks to Dr. B. G. Deshpande, O. and N.G.C. and to Prof. P. V. Sowani, Fergusson College, for encouragement and to Prof. Mrs. Sharma, N. W. College, Poona, Shri B. S. Apte, Chief Engineer, and Shri Dhamdhare, Executive Engineer, Koyana, for their kind co-operation.

## LETTERS TO THE EDITOR

### A NEW FORM OF THE ROBERTSON-WALKER COSMOLOGICAL LINE-ELEMENT

SEVERAL forms of the well-known Robertson-Walker cosmological line-element are available in literature. We give below one more form and the transformations leading to the Robertson-Walker metric. The new form may be written as

$$ds^2 = dt'^2 - R^2(t) (dx'^2 + F^2 dy'^2 + G^2 dz'^2) \quad (1)$$

with

$$\begin{aligned} (i) & F = \cos(kx + a), \quad G = \sin(kx + a), \\ (ii) & F = \cosh(kx + a), \quad G = \sinh(kx + a), \\ (iii) & F = G = 1. \end{aligned} \quad (2)$$

It is interesting to note that the square of  $k$ , appearing in (2), is the curvature of the 3 space-sections  $t = \text{constant}$  in relativistic cosmological models. The expressions (2) (i), (ii), (iii) on substitution in (1) give respectively cosmological models with  $k^2$  being positive, negative and zero.

The metric (1) with (2) (i) can be transformed to the well-known spherically symmetric form

$$ds^2 = dt'^2 - R^2(t) \left[ \frac{dr'^2}{1 - k^2 r'^2} + r'^2 (d\theta'^2 + \sin^2 \theta' d\phi'^2) \right]$$

with the help of the transformation

$$\begin{aligned} r \sin \theta &= \left( \frac{1}{k} \right) \sin(kx + a) \\ \sqrt{1 - k^2 r'^2} &= k \tan ky, \quad \phi = kz \end{aligned} \quad (4)$$

The metric (1) with (2) (ii) can be brought to the spherically symmetric form

$$ds^2 = dt'^2 - R^2(t) \left[ \frac{dr'^2}{1 + k^2 r'^2} + r'^2 (d\theta'^2 + \sin^2 \theta' d\phi'^2) \right] \quad (5)$$

with the help of the transformation

$$\begin{aligned} r \sin \theta &= \left( \frac{1}{k} \right) \sinh(kx + a) \\ \sqrt{1 + k^2 r'^2} &= k \tanh ky, \quad \phi = kz \end{aligned} \quad (6)$$

The transformation of (1) with (2) (iii) to the spherically symmetric form is obvious and the transformations given in (4) and (6) are non-singular. A further well-known transfor-

mation takes (3) and (5) into the Robertson-Walker form.

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Gujarat, November 11, 1967.

### ON EMISSION SPECTRA OF URANYL-EDTA COMPLEXES

THE EDTA complex with uranyl, prepared by adding to the concentrated solution of disodium EDTA a solution of uranyl nitrate, is strongly fluorescent. Table I gives bands observed at 80° K. The resonance band  $B_0$  is at ca 20218 cm.<sup>-1</sup> There appear three quanta of  $\nu_1$  (830 cm.<sup>-1</sup>) and one quantum each of  $\nu_3$  (910 cm.<sup>-1</sup>) and a lattice vibration 28 cm.<sup>-1</sup> A second series of bands  $B_0'$  starts at ca 19967 cm.<sup>-1</sup> which is not due to the participating  $\nu_1$  as this forms a series with one quantum of  $\nu_3$  (945 cm.<sup>-1</sup>) and at least three quanta of  $\nu_1$  (825 cm.<sup>-1</sup>) and on exposure to ultraviolet at room temperature loses intensity and finally vanishes. Thus the B' fluorescence series is due to photo-sensitive species which dissociates under the action of ultraviolet radiation. The B series is also photo-sensitive but vanishes on larger ultraviolet exposure. The  $B_1$  series is not observed in absorption.

TABLE I

Fluorescence bands of uranyl EDTA complex at L.A.T.

Group	Position in cm. <sup>-1</sup>	Nature	Designation	Interpretation
I	20221	w, s	$B_0$	Resonance band
	20192	vw, S	L	$B_0 - 29$
	19967	w, S	$B_0'$	Second species
	19618	w, S		Ligand
	19290	S, b	$B_1$	$B_0' - \nu_1$ (831)
II	19359	vw, S		$B_1 - L$
	19310	w, b	$C_1$	$B_0 - \nu_3$ (911)
	19142	u, s	$B_1'$	$B_0' - \nu_1$ (825)
	19106	w, s		$B_0' - \nu_1 - L$
	19020	w, s	$C_1'$	$B_0' - \nu_3$ (945)
	18560	w, s	$B_2$	$B_0 - 2\nu_1$
	18495	w, s	$C_2$	$B_0 - \nu_1 - \nu_3$
	18281	w, s	$B_2'$	$B_0' - 2\nu_1$
IV	18204	w, s	$C_2'$	$B_0' - \nu_1 - \nu_3$
	17755	vw, d	$B_3$	$B_0 - 3\nu_1$
	17655	w, d	$B_3'$	$B_0' - 3\nu_1$

In general EDTA forms 1:1 complexes with most of the cations.<sup>1</sup> These complexes have

been assigned structures by Schwarzenbach and Ackermann.<sup>2</sup> Hara and West<sup>3</sup> have reported that for pH range 3.5 to 4 EDTA forms a stable compound with uranyl, metal to EDTA ratio being 2:1. The chelate is probably a pseudo salt. It appears that both types of complexes are formed, the mono-species being in a smaller quantity. The dashed series is, thus, identified as due to mono-species. Finally it is to be remarked that the symmetric uranyl frequency is considerably reduced indicating a strong complexing in the equatorial plane of uranyl ion.

We express our thanks to the C.S.I.R. for financial assistance.

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Naini Tal, December 5, 1967.

1. Welcher, F. J., *The Analytical Uses of EDTA*, D. Van Nostrand Co., Princeton, 1958.
2. Schwarzenbach, G. and Ackermann, H. *Helv. Chim. Acta*, 1947, **30**, 1798; 1948, **31**, 1929; *Chem. Abs.*, 1948, **42**, 1523, 6696.
3. Hara, K. and West, P. W., *Anal. Chem. Acta*, 1955, **12**, 285.

### STUDIES OF HYDROGEN BONDING IN METHANOL-AMIDE COMPLEXES

RECENTLY Kanekar *et al.*<sup>1</sup> studied solvent-solute interactions of OH protons of methanol in N, N-dimethylformamide and N, N-dimethylacetamide using proton magnetic resonance. They have shown that the H bond interaction is stronger for dimethylacetamide than for dimethylformamide. We report in this note the infrared studies of hydrogen bonding between methanol and several tertiary amides in order to study the strength of the H bond interaction in these complexes. The infrared spectra of OH stretching absorption band of methanol in solutions of  $\text{CCl}_4$  and the amides were recorded with Perkin Elmer Model 221 spectrophotometer with matched quartz cells of 3 cm. thickness and suitable gear combination was chosen so as to spread the spectra in this region. Molar concentrations of the order of 0.008 of methanol in  $\text{CCl}_4$  were used so as to eliminate the intermolecular associations and study the effect of the amides on the free O-H stretching absorption band. The spectra were recorded with (i) methanol in  $\text{CCl}_4$  in the sample beam with  $\text{CCl}_4$  in the reference beam and (ii) methanol in  $\text{CCl}_4$  in the presence of the amide in the sample beam with the amide of same concentration

in  $\text{CCl}_4$  in the reference beam. Some of these spectra are shown in Figs. 1 and 2.

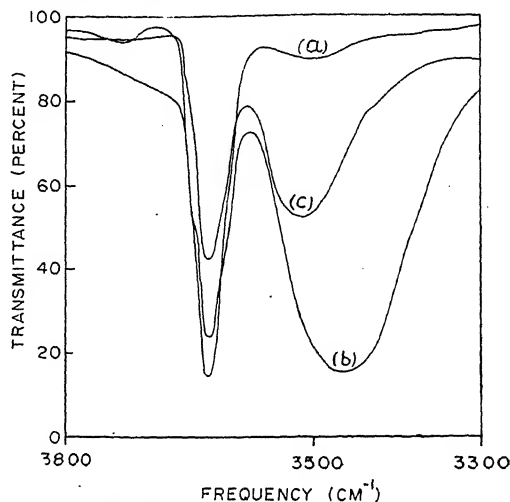


FIG. 1. Infrared spectra of O-H stretching band of methanol (a) in  $\text{CCl}_4$ , (b) in  $\text{CCl}_4$  in the presence of dimethylbenzamide and (c) in  $\text{CCl}_4$  in the presence of diphenylbenzamide.

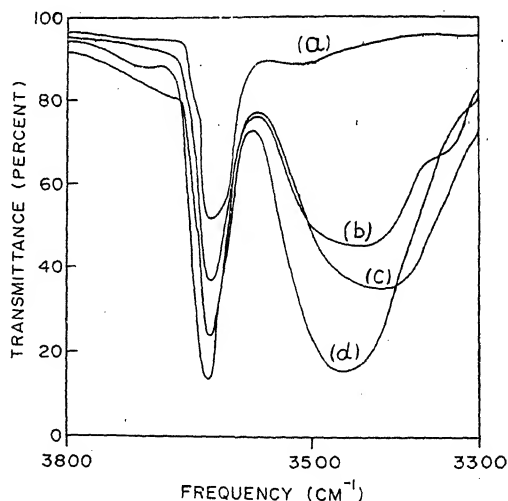


FIG. 2. Infrared spectra of O-H stretching band of methanol (a) in  $\text{CCl}_4$ , (b) in  $\text{CCl}_4$  in the presence of dimethylformamide, (c) in  $\text{CCl}_4$  in the presence of dimethylacetamide and (d) in  $\text{CCl}_4$  in the presence of dimethylbenzamide.

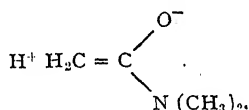
The free and the bonded OH stretching frequencies of methanol in the presence of various tertiary amides are given in Table I.

It is well known that two possible resonance structures contribute to the resonance hybrid in amides and that the dipolar resonance structure makes substantial contribution to the ground state of the molecule enhancing the

TABLE I

Amide		Molar conc. of methanol	Molar conc. of the amide	OH stretching frequency of methanol in $\text{cm}^{-1}$		Difference between free and bonded frequencies in $\text{cm}^{-1}$
				Free	Bonded	
Dimethylformamide	..	0.01	0.05	3628	3459	169
Diphenylformamide	..	0.008	0.04	3628	3512	116
Dimethylacetamide	..	0.01	0.05	3628	3431	197
Diphenylacetamide	..	0.008	0.04	3628	3481	147
Dimethylbenzamide	..	0.01	0.05	3628	3463	165
Diphenylbenzamide	..	0.01	0.05	3628	3513	115

polarity of the C=O group. In the LCAO-MO terms, the high polarity of the C=O group in amides is due to the interaction of  $\pi$ -orbitals of the C=O group and  $2P_z$  orbital of the nitrogen atom. This explains for the manifestation of relatively strong H bonds in the methanol-tertiary amide complexes, as indicated by differences of the order of  $115 \text{ cm}^{-1}$  to  $197 \text{ cm}^{-1}$  in the free and bonded OH stretching frequencies (Table I). Of the dimethyl amides, the difference between the free and bonded OH stretching frequencies is higher in the case of dimethylacetamide than in cases of dimethylformamide and dimethylbenzamide. H bond is therefore stronger with dimethylacetamide than with the other two amides and this is due to hyperconjugation as a result of the contribution of the structure



In diphenyl amides, there is a competitive effect of the phenyl ring for the lone pair of electrons on the N atom with the result the contribution of the dipolar resonance structure is considerably reduced in these molecules resulting in the reduction of the polarity of the C=O bond. The H bond interaction in methanol-diphenyl amide complexes is therefore weaker compared to those in the corresponding methanol-dimethyl amide complexes.

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Osmania University,  
Hyderabad-7 (A.P.), December 8, 1967.

1. Kanekar, C. R., Khetrapal, C. L., Venkata Ramiah, K. and Indira Chary, C. A., *Proc. Ind. Acad. Sci.*, 1967, **66**, 189.

### ELECTRIC FIELD GRADIENTS AND COVALENCY IN ARSENIC TRI-IODIDE

In recent years several interesting calculations were made on the nuclear quadrupole resonance frequencies in ionic crystals using the point charge model. In some cases there is good agreement between the observed and calculated values and in other cases there is no such agreement. The lack of agreement is attributed usually to partial covalent nature of the bonds. The purpose of the present note is to calculate the field gradient tensor of  $\text{AsI}_3$  at the arsenic site, on the point charge model, and hence to calculate the resonance frequency. The deviation between the calculated and observed frequencies is attributed to the predominant covalent nature of the bonds and is used to estimate the degree of covalency.

The crystal structure of  $\text{AsI}_3$  is well known.<sup>1</sup> The unit cell is rhombohedral and the pseudocell contains 6 molecules. All the arsenic atoms as well as the iodine atoms are both physically and chemically equivalent. In calculating the field gradients the rhombohedral system is first converted into hexagonal system through the equations

$$\begin{aligned} X_h &= \frac{(X - Z)}{3} \\ Y_h &= \frac{(Y - Z)}{3} \\ Z_h &= \frac{(X + Y + Z)}{3} \end{aligned}$$

The contributions to the field gradients due to the individual ions are calculated from the equations:<sup>2,3</sup>

$$\begin{aligned} q_{xx} &= \frac{e}{r^3} \left( 1 - \frac{3x^2}{r^2} \right) & q_{xy} &= -\frac{3exy}{r^5} \\ q_{yy} &= \frac{e}{r^3} \left( 1 - \frac{3y^2}{r^2} \right) & q_{yz} &= -\frac{3eyz}{r^5} \\ q_{zz} &= \frac{e}{r^3} \left( 1 - \frac{3z^2}{r^2} \right) & q_{zx} &= -\frac{3exz}{r^5} \end{aligned}$$

The charges are taken as  $+3e$  on the arsenic ion and  $-e$  on the iodine ions. The field gradient tensor in a rectangular co-ordinate system, with its X and Z axes coinciding with the X and Z axes of the hexagonal system, is obtained as

$$\begin{vmatrix} -1.623 & 0 & 0 \\ 0 & -1.623 & 0 \\ 0 & 0 & +3.246 \end{vmatrix} \cdot e \cdot 10^{-14} \text{ e.s.u.}$$

On account of the symmetry of the crystal the asymmetry parameter ' $\eta$ ' is equal to zero. Taking for the Sternheimer correction factor ' $\gamma_a$ ' a value  $-29$  which was obtained by Blombergen and Gill<sup>4</sup> by interpolation (in the absence of a theoretical value for this factor) the calculated resonance frequency comes out as 508.5 MC/sec. from the equation (for spin  $i = 3/2$ )

$$\nu = \frac{1}{2} \left( \frac{eQq}{h}, (1 - r_a) \left( 1 + \frac{\eta^2}{3} \right) \right)^{\frac{1}{2}}.$$

Comparing the value with the observed value of 116.8 MC/sec.<sup>5</sup> the extremely large deviation has to be attributed to the predominant covalent nature of the bonding between the arsenic and iodine atoms. On the basis that the effect of this covalency is to reduce the effective charges associated with each ion, arsenic ions are given a charge of  $+3e(1-s)$ , while the iodine ions are associated with a charge of  $-e(1-s)$ . An attempt is then made to estimate the value of ' $s$ ', which gives agreement between calculated and observed resonance frequencies. ' $s$ ' comes out as 0.7918, which is equivalent to about 80% of covalent nature of the bonds.

In view of the large discrepancy between observed and calculated values of the resonance frequencies on the basis of the purely point charge model, the large amount of covalency seems reasonable. As a verification of the result, calculations of the field gradients and resonance frequencies of the iodine atoms are desirable. These calculations are in progress.

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Post-Graduate Centre,  
Guntur, December 21, 1967.

1. Wyckoff, R. W. G., *Crystal Structures*, Interscience Publishers, Inc., New York, 1915.
2. Bersohn, R., *J. Chem. Phys.*, 1958, **29**, 326.
3. Rao, D. V. G. L. N. and Narasimha Murty, A., *Phys. Rev.*, 1963, **132**, 961.
4. Gill, D. and Blombergen N., *Ibid.*, 1963, **129**, 2398.
5. Barnes, R. G. and Bray, P. J., *J. Chem. Phys.*, 1955, **23**, 407.

## THE LOW-LYING ENERGY LEVELS OF $O^{18}$ NUCLEUS

The theoretical investigations on the energy levels of  $O^{18}$  nucleus are of considerable interest since both the shell<sup>1-3</sup> and deformed<sup>4,6</sup> models were successful in obtaining a qualitative agreement between the experimental and theoretical level spacings and spin assignments. However in the present letter we report a new shell model level assignments and spacings for  $O^{18}$  nucleus.

In the present calculations  $O^{18}$  nucleus is considered on the basis of intermediate-coupling individual particle model as consisting of a doubly magic core plus two extra-neutrons in a  $(2s-1d)$  shell. A modified Gaussian type of radial interaction which is intermediary to both Yukawa and Gaussian potentials has been used<sup>7</sup> for the radial part of the two-body interaction between the extra-core neutrons. The single particle level spacings between  $d_{5/2}-d_{3/2}$  and  $d_{5/2}-s_{1/2}$  are first taken to be the same as that observed in  $O^{17}$  nucleus [(see Fig. 1 (A))]. Several exchange mixtures like those of Serber, Rosenfeld, Soper, Ferr and Vischer, Inglis are used and a study of the  $T=1$  level spacings, with the lowest  $0^+$  level as the ground state of  $O^{18}$  nucleus, has been made with a variable strength parameter of the two-body potential.

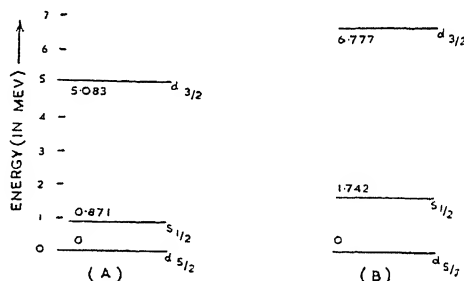


FIG. 1. The spin-orbit splittings of the  $(2s-1d)$  shell. (A) Experiment values of  $O^{17}$  nucleus. (B) Enhanced spin-orbit splittings.

Best fit (given in Fig. 2 A) with the experimental levels is obtained with an exchange mixture.

$W = 0.27$ ,  $M = 0.93$ ,  $H = 0.26$ ,  $B = -0.47$  which retains the predominant Majorana exchange character. The strength parameter chosen to give the first excited  $2^+$  state is found to be  $-16$  Mev which leads to about half the value of  $\Delta^{31}V_0$  given by Flowers and Wilmore.<sup>3</sup>

The evaluated level spacings are too low in energy and to improve the agreement between

the theoretical and experimental levels<sup>8,9</sup> (given in Fig. 2) a modified spin-orbit splitting has been assumed. This means that the average nuclear field in which the extra-core neutrons of  $O^{18}$  nucleus exist is considerably different from that for the odd neutron  $O^{17}$  nucleus. The final values of the modified spin-orbit splittings used and the evaluated levels of  $O^{18}$  nucleus with these are given in Fig. 1 (B) and Fig. 2 (B) respectively.

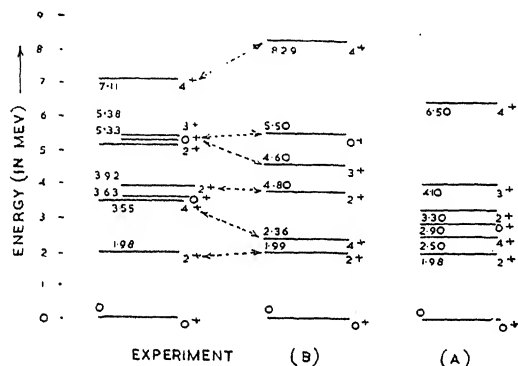


FIG. 2. The comparison of predicted and observed low-energy levels of  $O^{18}$  nucleus. (A) Theoretical level scheme with  $O^{17}$  level scheme. (B) Predicted energy level scheme with enhanced spin-orbit splittings.

From Fig. 2 (B), we note that good agreement is obtained for the second excited  $2^+$  state with the observed 3.92 Mev level. Both the  $4^+$  levels and the  $3^+$  level predicted differ by about 1 Mev from the observed spin levels at 3.55 Mev, 7.11 Mev and 3.63 Mev respectively. These are dependent, on the assumed exchange character and  $d_{5/2}-d_{3/2}$  level spacing. The predicted second excited state is situated at about 5 Mev level and must be chosen as the experimentally observed 5.33 Mev level. Since for these levels the theory and experiment are in good agreement we expect the ground state, 1.98 Mev and 3.55 Mev to be almost pure states of  $d_{5/2}^2$  configuration and 3.92 Mev, 5.33 Mev and 7.11 Mev to be predominantly  $s_{1/2}^2$ ,  $s_{1/2}^2$  and  $d_{5/2}-d_{3/2}$  configurational states respectively. Somewhat lower configurational amplitudes than these are obtained by Moreh and Daniels<sup>10</sup> for these essentially shell model states probably since they made an analysis of the stripping reactions based on a deformed model.

No  $0^+$  level around 3.63 Mev level is predicted in the present calculations. Probably this state arises due to weak coupling of the odd-parity levels of the core of  $O^{18}$  nucleus and the extra-core neutrons two-body inter-

action. In view of the sensitive dependence of the  $O^{18}$  nuclear levels on the exchange character and the modifications in the spin-orbit splittings we note that the  $O^{18}$  nucleus must be treated on a special footing<sup>2,3</sup> and hence the doubly magic core of  $O^{18}$  nucleus need not be the same as the  $O^{16}$  nucleus. An assumption of  $0^+$ ,  $1^-$ ,  $2^+$  as the low-levels of this core<sup>10</sup> gives rise to a number of low-lying levels for the  $O^{18}$  nucleus, just as in a vibrational model. However, the reasonable agreement obtained in the present calculations for ground state, 1.98 Mev, 3.55 Mev, 3.92 Mev, 5.33 Mev and 7.11 Mev will not be affected much by the weak coupling since they involve the  $0^+$  ground state of the core of the nucleus.

For detailed calculations including higher configurational interaction on these lines, an experimental confirmation that the 5.33 Mev level is predominantly  $s_{1/2}^2$  configurational  $0^+$  state would be helpful, thus justifying the adopted spin-orbit modifications in the shell model.

The author wishes to express his sincere thanks to Dr. C. Santhamma and Professor K. R. Rao, Andhra University Colleges, Waltair, and Dr. N. A. Narasimham, Spectroscopy Division, Bhabha Atomic Research Centre, Bombay, for their kind interest in this work and encouragement. He is thankful to Sri, Ch. V. S. Ramachandra Rao for help in carrying out the numerical computations on the electronic computer at BARC, Bombay.

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December 29, 1967.

1. Redlich, M. G., *Phys. Rev.*, 1958, **110**, 468; *Ibid.*, 1955, **99**, 1421, 1427.
2. Flowers, B. H. and Wilmore, D., *Proc. Phys. Soc.*, 1964 **83**, 683.
3. Narayana, K. L., *Ph.D. Thesis*, Andhra University, Waltair, 1964.
4. Federman, P. and Talmi, I., *Phys. Letters*, 1965, **15**, 165.
5. Brown, G. E., *Proc. Paris Conf. on Nuclear Structure*, 1. 64; Engeland, T., *Nucl. Phys.*, 1965, **72**, 68.
6. Benson, H. G. and Irvine, J. M., *Proc. Phys. Soc.*, 1966, **89**, 249; Federman, P., *Nucl. Phys.*, 1967, **95**, 443.
7. Narayana, K. L., *Curr. Sci.*, 1966, **35**, 38.
8. Lutz, H. F. and Eccles, S. F., *Nucl. Phys.*, 1966, **811**, 423.
9. Wiza, J. L., Middleton, R. and Kewka, P. V., *Phys. Rev.*, 1966, **141**, 975.
10. Berggren, T., Eriksson, T. and Narayana, K. L., *Proc. 13th Swedish National Physics Conf.*, University of Upsala, Upsala, Sweden.

### THE NEAR ULTRA-VIOLET ABSORPTION SPECTRUM OF 2, 4-DICHLOROTOLUENE

THE near ultra-violet absorption spectrum of 2, 4-dichlorotoluene in vapour phase has been photographed using Zeiss Medium Quartz Spectrograph with cell lengths ranging from 10 to 150 cm. The temperature was varied between  $-10^{\circ}$  and  $80^{\circ}$  C. A Xenon lamp was used as the source of continuous radiation. Ilford N-40 plates were used to record the spectrum.

All the bands have been analysed in terms of two ground state and five excited state frequencies with correlation of Raman<sup>1</sup> and Infra-red<sup>2</sup> spectra. The ground state fundamentals are 130 and  $170\text{ cm}^{-1}$  and the excited state frequencies are 372, 684, 823, 1114 and  $1189\text{ cm}^{-1}$ . These frequencies along with their probable modes of vibrations are shown in Table I.

There are bands at separations of 40, 74 and  $99\text{ cm}^{-1}$  on the longer wavelength side of the (0,0) band. These may be due to  $\nu'-\nu''$

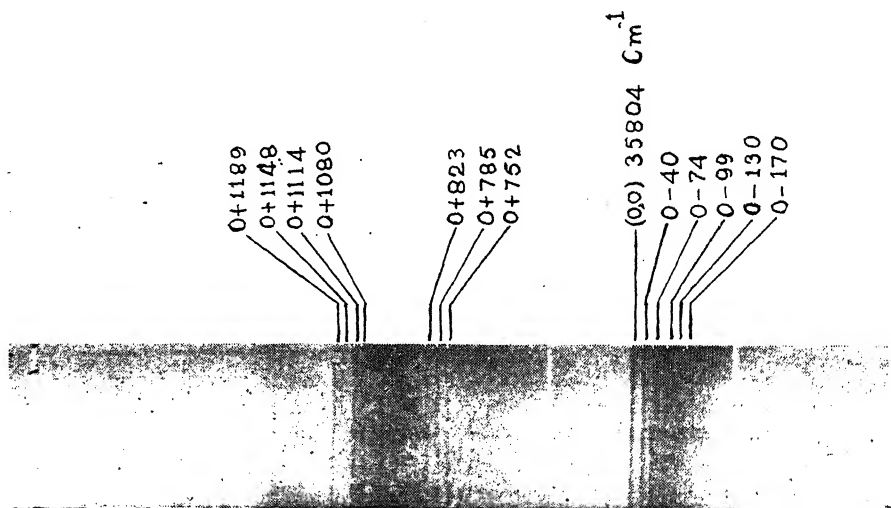


FIG. 1. Near ultra-violet absorption spectrum of 2, 4-dichlorotoluene.

TABLE I  
Fundamental vibrational frequencies for 2, 4-dichlorotoluene

Raman liquid at $30^{\circ}$ C.		Ultra-violet absorption frequencies		Band type	Mode of vibration
Landolt Börnstein	Deb and Banerjee	G.S.	E.S.		
122 (3)	127 (3) D	130 (2)			
181 (7)	181 (6) D	170 (2.5)			
378 (7)	380 (8) P		370 (1)	$a'$	C—Cl bending i.p.
704 (6)	705 (8) P		684 (2)	$a'$	do.
832 (6)	834 (8) P		823 (4)	$a'$	ring breathing
1143 (3)	1145 (4) P		1114 (4)	$a'$	C—H bending
1203 (5)	1204 (6) P		1189 (6)	$a'$	C—CH <sub>3</sub> stretching

Letters in parenthesis indicate observed intensities; P=polarized; D=depolarized; i.p.=in plane; o.p.=out of plane; G.S.=ground state; E.S.=excited state.

The strongest band at  $2792.129\text{ Å}$  ( $35804\text{ cm}^{-1}$ ) has been identified as the (0,0) band observed even at the lowest pressure. The bands are extended from  $2900\text{ Å}$  to  $2400\text{ Å}$ . The symmetry of the molecule is supposed to be  $C_2$ , and the transition involved in this case is assumed to be of the type  $\pi-\pi^*$  ( $1A'-1A'$ ).

transition of low lying vibrations in the two electronic states.

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1. Landolt Börnstein, "Zahlenwerte und Funktionen, 1 Band," *Atom Und Molekulare Physik*, 1951, p. 523.
2. Deb, K. K. and Banerjee, S. B., *Ind. J. Phys.*, 1960, 34, 247.

### A NEW COMPONENT OF THE FLOWERS OF *THESPIESIA POPULNEA*: (+) GOSSYPOL

The flowers of *Thespesia populnea* were earlier studied by Seshadri and co-workers<sup>1</sup> and were found to contain kempferol, populin (kempferol 7-glucoside), herbacetin (mostly as glucoside) and a phenolic compound which was named 'populneol'. It was also reported that populneol was present only in some samples of the flowers but not in others. We have been interested in the study of populneol and in order to isolate more of this substance a number of samples of the flowers of *T. populnea* from different localities in India were examined in detail. These were successively extracted with petroleum ether, ether, acetone and alcohol. In the ether, acetone and alcoholic concentrates were found  $\beta$ -sitosterol, herbacetin, kempferol, populin and small amounts of a flavonoid (apparently a new one) and other flavonoid glycosides which yielded, on acid hydrolysis, glucose and rhamnose. No populneol could be obtained from any of the flowers studied.

The petroleum ether concentrate gave a yellow compound which on crystallisation from benzene had m.p. 184°;  $\beta$ -carotene and a substance giving positive Liebermann-Burchardt reaction were found in the mother liquors. The yellow compound was a single entity (TLC on silica gel; toluene-ethyl acetate-formic acid, 5:4:1; strong sulphuric acid as spray). It gave a deep green ferric reaction, a bright red solution in concentrated sulphuric acid and a yellow solution in alkali which gradually became violet. It did not show any of the colour reactions typical of flavonoids. Other data for the compound are:  $[\alpha]_D^{170} + 475^\circ$  (C, 2.54, chloroform); U.V. absorption (m $\mu$ ): 237 and 378; I.R. (cm<sup>-1</sup>): 3650, 3600 (broad), 2780 (aromatic aldehyde

CH), 1630 (chelated C=O), 1600, 1575; methyl ether (after preparative TLC), m.p. 259°,  $[\alpha]_D^{170} + 159^\circ$  (C, 1.73, chloroform), M<sup>+</sup> 602; acetate, m.p. 250°,  $[\alpha]_D^{170} + 233^\circ$  (chloroform). The substance also forms an anil readily. Analytical data of the yellow compound and its derivatives agreed with the formula C<sub>30</sub>H<sub>30</sub>O<sub>8</sub> and the mass spectrum of the methyl ether showed a prominent fragment at m/e 301 in addition to the molecular ion at 602, thus indicating the symmetrical nature of the molecule. These data led to the conclusion that the yellow compound is most probably gossypol and this was confirmed by direct comparison with an authentic sample isolated from the cotton seeds and its derivatives (mixed m.p., U.V., I.R., N.M.R. and co-TLC): It is interesting to note that while no optical activity could be detected in gossypol from the cotton-seeds the present sample shows high dextro rotation. It is known that gossypol and its derivatives show considerable variation in melting points.<sup>2-3</sup>

Gossypol has not so far been reported to occur in plants other than cotton. The optical activity seems to arise due to restricted rotation of the naphthalene units similar to that encountered in the diphenyl derivatives substituted in all the *ortho* positions. Recent examples of binaphthyl derivatives showing optical activity are the ustilaginoidins.<sup>4</sup>

Thespesin reported to be present in the fruits of *T. populnea*<sup>5</sup> has been suggested to have a flavonoid structure. But many of its properties indicate that it may be (+) gossypol. We have therefore examined the fruits and found that the pericarp yields almost pure (+) gossypol by extraction with petroleum ether.

Department of Chemistry, S. C. DATTA.  
Delhi University, V. V. S. MURTI.  
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1. Rao, P. R. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1946, 24A, 456 and earlier papers.
2. Adams, R. et al., *J.A.C.S.*, 1938, 60, 2193 and other papers.
3. Chander, K. and Seshadri, T. R., *J.S.I.R. (India)*, 1958, 17B, 279 and earlier references.
4. Morishita, E. and Shibata, S., *Chem. Pharm. Bull.*, 1967, 15, 1772 and other papers.
5. Srivastava, S. N. et al., *Ind. J. Chem.*, 1963, 1, 451.

**$\alpha$ -(2-ETHYL 4:5 DIMETHOXY PHENYL)-  
BUTYLAMINE AS A GRAVIMETRIC  
REAGENT FOR COPPER (II)**

THE paper describes the use of  $\alpha$ -(2-ethyl 4:5 dimethoxy phenyl)-butylamine as an analytical reagent for Cu(II). It has been found that the reagent in an ethanolic solution forms a light blue precipitate with Cu(II). This precipitation of Cu(II) was found to be quantitative between pH 4.5 and 6.0.

$\alpha$ -(2-ethyl 4:5 dimethoxy phenyl) butylamine was prepared as described by Sharma and Kachru.<sup>1</sup>

A standard aqueous solution of Cu(II) containing 10 to 30 mg. of Cu(II) was diluted to about 100 ml. and heated to boiling and the reagent solution (1% in ethanol) added gradually. The pH of the solution was then raised gradually using dilute solution of ammonia. Cu(II) was precipitated completely in the neighbourhood of pH 5.0. At lower pH values the estimation yielded low values.

After precipitation, the complex was digested on a water-bath for about 15 minutes, filtered and washed thoroughly with hot aqueous alcohol. It was then ignited till constant weight was obtained. The results of the estimations are summarised in Table I.

TABLE I

*Estimation of Cu(II) by  $\alpha$ -(2-ethyl 4:5 dimethoxy phenyl) butylamine*

pH	Wt. of oxide found mg.	Wt. of oxide taken mg.	% of ppt.
5.2	16.6662	16.6670	99.99
5.8	25.0000	25.0359	99.99
6.0	25.0028	25.0359	99.99

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**SYNTHESIS OF SOME NEW  
6-iodo-S-SUBSTITUTED-2-THIO-3-AR  
4-QUINAZOLONES AS POSSIBLE  
ANTIMALARIALS**

THE present note reports studies on the thesis of 6-iodo-S-substituted-2-thio-3-4-quinazolones from 5-iodoanthranilic (Blatt, *Organic Synthesis*, Coll. Vol. II, p. arylisothiocyanates and halogen. compo (prepared by the interaction of second amines and chloroacetyl chloride).

**EXPERIMENTAL**

6-Iodo-2-mercapto-3-m-chlorophenylquinazalone: Equimolecular quantities of iodoanthranilic acid (10.0 g.) and m-ch. phenylisothiocyanate (6.4 g.) were refluxed in ethanol (65 ml.) on a water-bath for 3-4 h. The product, on cooling, was filtered, washed with a little ethanol, dissolved in 10% sodium hydroxide solution and precipitated by addition of dilute hydrochloric acid. It was filtered and crystallised from a mixture of chlorobenzene and ethanol (2:1).

Similarly, 3-o-methoxyphenyl-, -o-ethylphenyl-, - $\alpha$ -naphthyl-6-iodo-2-mercaptoquinazolones were prepared. The yields, melting points, and analytical data of these compounds are listed in Table I.

6-Iodo-2-N, N-diethylcarboxamidomethylthio-3-m-chlorophenyl-4-quinazalone: 6-Iodo-2-mercapto-3-m-chlorophenyl-4-quinazalone (7.5 g.) was dissolved in just sufficient alcoholic sodium hydroxide solution and treated with N, N-diethylchloroacetamide (4 ml.) dissolved in minimum quantity of ethanol. The whole mixture was stirred and allowed to stand for 25 minutes when a crystalline precipitate was observed. It was filtered, washed several times with water and finally with a little ethanol. The product was finally crystallised from ethanol.

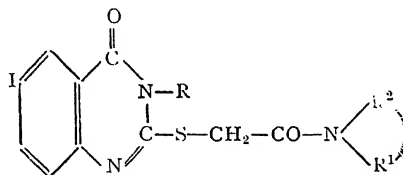
Similarly, 2-N, N-methylphenylcarboxamidomethylthio-, -ethylphenylcarboxamidomethylthio-, -benzylphenylcarboxamidomethylthio-, -piperidinocarboxamidomethylthio derivatives of 6-iodo-2-mercapto-3-aryl-4-quinazolones have been prepared. Their yields, melting points and analytical data are recorded in Table I.

Compound numbers 7, 10 and 15 (Table I) were tested for their antimalarial activity against *P. gallinaceum* infection in chicks at the National Institute of Communicable Diseases, Delhi (India), but none of them was found to be active.

1. Sharma, H. N. and Kachru, C. N., *Jour. Indian Chem. Soc.*, 1959, **36**, 117.

TABLE I  
6-Iodo-2-mercapto-3-aryl-4-quinazolones

S. No.	Aryl group -R-	Yield %	M.P. °C.	Molecular formula	Nitrogen %		Sulphur %	
					Found	Calcd.	Found	Calcd.
1	<i>m</i> -Chlorophenyl	.. 60	296	C <sub>14</sub> H <sub>8</sub> N <sub>2</sub> SOICl	6.78	6.75	7.78	7.72
2	<i>o</i> -Methoxyphenyl	.. 65	290	C <sub>15</sub> H <sub>11</sub> N <sub>2</sub> SO <sub>2</sub> I	6.80	6.83	7.54	7.82
3	<i>o</i> -Ethoxyphenyl	.. 60	279	C <sub>16</sub> H <sub>13</sub> N <sub>2</sub> SO <sub>2</sub> I	6.29	6.60	7.46	7.55
4	$\alpha$ -Naphthyl	.. 65	316	C <sub>18</sub> H <sub>11</sub> N <sub>2</sub> SOI	6.35	6.51	7.54	7.44

TABLE II  
6-Iodo-2-N, N-disubstituted carboxamidomethylthio-3-aryl-4-quinazolones

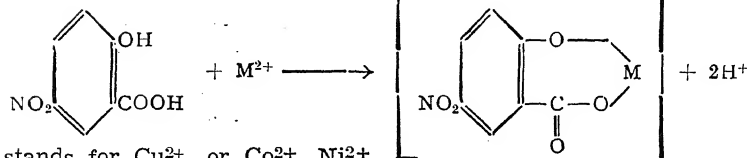
No.	R	R <sup>1</sup>	R <sup>2</sup>	Yield %	M.P. °C.	Molecular formula	Nitrogen %		Sulphur %	
							Found	Calcd.	Found	Calcd.
1	<i>m</i> -Chloro phenyl	.. Ethyl	Ethyl	60	206	C <sub>26</sub> H <sub>19</sub> N <sub>3</sub> SO <sub>2</sub> ICl	7.68	7.96	6.18	6.06
2	<i>o</i> -Methoxy phenyl	.. "	"	65	134	C <sub>21</sub> H <sub>22</sub> N <sub>3</sub> SO <sub>3</sub> I	7.95	8.03	6.23	6.11
3	<i>o</i> -Ethoxy phenyl	.. "	"	60	149	C <sub>22</sub> H <sub>24</sub> N <sub>3</sub> SO <sub>3</sub> I	7.63	7.82	6.04	5.95
4	$\alpha$ -Naphthyl	.. "	"	65	190	C <sub>24</sub> H <sub>22</sub> N <sub>3</sub> SO <sub>3</sub> I	7.55	7.73	5.83	5.89
5	<i>m</i> -Chloro phenyl	.. Methyl	Phenyl	55	230	C <sub>23</sub> H <sub>17</sub> N <sub>3</sub> SO <sub>3</sub> ICl	7.15	7.48	5.66	5.70
6	<i>o</i> -Methoxy phenyl	.. "	"	60	197	C <sub>24</sub> H <sub>20</sub> N <sub>3</sub> SO <sub>3</sub> I	7.46	7.54	5.78	5.74
7	<i>o</i> -Ethoxy phenyl	.. "	"	60	200	C <sub>25</sub> H <sub>22</sub> N <sub>3</sub> SO <sub>3</sub> I	7.25	7.36	5.55	5.60
8	$\alpha$ -Naphthyl	.. "	"	65	217	C <sub>27</sub> H <sub>20</sub> N <sub>3</sub> SO <sub>3</sub> I	6.97	7.27	5.38	5.54
9	<i>m</i> -Chloro phenyl	.. Ethyl	"	58	237	C <sub>24</sub> H <sub>19</sub> N <sub>3</sub> SO <sub>3</sub> ICl	6.96	7.30	5.33	5.56
10	<i>o</i> -Methoxy phenyl	.. "	"	60	236	C <sub>25</sub> H <sub>22</sub> N <sub>3</sub> SO <sub>3</sub> I	7.01	7.36	5.45	5.60
11	<i>o</i> -Ethoxy phenyl	.. "	"	58	215	C <sub>26</sub> H <sub>24</sub> N <sub>3</sub> SO <sub>3</sub> I	6.95	7.18	5.31	5.47
12	$\alpha$ -Naphthyl	.. "	"	65	225	C <sub>28</sub> H <sub>22</sub> N <sub>3</sub> SO <sub>3</sub> I	7.01	7.70	5.48	5.41
13	<i>m</i> -Chloro phenyl	.. Benzyl	"	60	189	C <sub>29</sub> H <sub>21</sub> N <sub>3</sub> SO <sub>3</sub> ICl	6.46	6.59	5.18	5.02
14	<i>o</i> -Methoxy phenyl	.. "	"	65	213	C <sub>30</sub> H <sub>24</sub> N <sub>3</sub> SO <sub>3</sub> I	6.60	6.63	5.22	5.06
15	<i>o</i> -Ethoxy phenyl	.. "	"	60	200	C <sub>31</sub> H <sub>26</sub> N <sub>3</sub> SO <sub>3</sub> I	6.38	6.49	5.11	4.95
16	$\alpha$ -Naphthyl	.. "	"	65	212	C <sub>33</sub> H <sub>24</sub> N <sub>3</sub> SO <sub>3</sub> I	6.35	6.43	4.82	4.90
17	<i>m</i> -Chloro phenyl	.. Piperidino	"	65	134	C <sub>21</sub> H <sub>19</sub> N <sub>4</sub> SO <sub>3</sub> ICl	7.62	7.78	6.03	5.93
18	<i>o</i> -Methoxy phenyl	.. "	"	60	157	C <sub>22</sub> H <sub>22</sub> N <sub>3</sub> SO <sub>3</sub> I	7.56	7.85	6.16	5.98
19	<i>o</i> -Ethoxy phenyl	.. "	"	60	185	C <sub>23</sub> H <sub>24</sub> N <sub>3</sub> SO <sub>3</sub> I	7.54	7.65	5.88	5.83
20	$\alpha$ -Naphthyl	.. "	"	64	140	C <sub>25</sub> H <sub>22</sub> N <sub>3</sub> SO <sub>3</sub> I	7.48	7.56	5.82	5.76

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### 5-NITRO-SALICYLIC ACID AS A COMPLEX FORMING LIGAND

THE survey of the literature<sup>1-4</sup> of metal complexes with 5-nitro-salicylic acid has shown that not much work has been done on the formation of metal complexes with this acid. Here we report our results on the reactions of Cu(II), Ni(II), and Co(II) with 5-nitro-salicylic acid in aqueous medium by potentiometric and conductometric methods.



where  $\text{M}^{2+}$  stands for  $\text{Cu}^{2+}$ , or  $\text{Co}^{2+}$ ,  $\text{Ni}^{2+}$ .

The potentiometric titrations of  $\text{Cu(II)}$ ,  $\text{Ni(II)}$  and  $\text{Co(II)}$  with 5-nitro-salicylic acid show a clear break at 1:1 indicating the formation of mono-5-nitro-salicylate according to the above equation.

For the conductometric measurements<sup>7</sup> different solutions were made by keeping the concentration of the metal constant and varying that of sodium-5-nitro-salicylate. In all cases the total volume was made constant by adding double-distilled water. When a graph is plotted between conductance and composition a clear break at 1:1 is obtained. This has been further confirmed by Job's method<sup>5</sup> of continuous variation at concentrations M/40, M/60 and M/80.

The value of the dissociation and stability constants have also been determined by Job's method<sup>5</sup> employing non-equimolar solutions. The results are summarised in Table I. The stability follows the order  $\text{Cu}^{2+} > \text{Ni}^{2+} > \text{Co}^{2+}$  which is the order to be expected by the Irving-William's<sup>6</sup> rule.

TABLE I

	K	$\Delta F^\circ$ (K.Calories/mole)
$\text{Cu(II)-5-nitro salicylate}$	229.10	-4.9744
$\text{Ni(II)-5-nitro-salicylate}$	168.00	-3.0768
$\text{Co(II)-5-nitro-salicylate}$	81.28	-2.6394

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1. Wendlandt, *Anal. Chem. Acta*, 1958, **18**, 316.
2. Shrivastava *et al.*, *J. Ind. Chem. Soc.*, 1960, **37**, 477.
3. Foye and Joseph, *J. Pharm. Sci.*, 1962, **51**, 329.
4. Kuzanetsov and Basangin, *Zhur. Neorgan. Khim.*, 1962, **7**, 814.
5. Job, P., *Ann. Chem.*, Paris, 1928, **10**, 9, 113.
6. Irving and William, *Nature*, 1948, **162**, 746.
7. Nayer and Pandey, *Proc. Ind. Acad. Sci.*, 1948, **27 A**, 284.

### CHEMICAL COMPOSITION OF A SPECIES OF PORPHYRA FROM VISAKHAPATNAM, S. INDIA

THE red seaweed, *Porphyra*, is a source of food in Japan, the British Isles, the Pacific coast of the United States, China and Philippines.<sup>1-3</sup> In India, only one of the species is found occurring at Visakhapatnam,<sup>4-6</sup> which has also been reported from Madras.<sup>7</sup> *Porphyra* is rich in vitamins A and B<sub>12</sub> and contains a high amount of carbohydrate and protein.<sup>3,8</sup> This note presents the results of chemical analysis of the Indian species of *Porphyra*.

The material was collected from Visakhapatnam on the east coast of South India. The monostromatic membranous thallus is attached to intertidal rocks and forms a prominent zone at about high water mark. The plants were collected on March 14, 1967 and rinsed first with sea-water and then with freshwater, air-dried and powdered. The powder thus obtained was used for the chemical analysis throughout and the results are expressed as percentage on dry weight of the alga. Triplicate analysis was carried out by two independent workers and the two sets of results were found to be very close to one another.

The conventional micro-kjeldahl method using selenium catalyst was used to determine organic nitrogen and from this the protein content was calculated by multiplying by a factor, 6.25. Carbohydrate was estimated colorimetrically using anthrone-sulphuric acid reagent. Crude fat was extracted with petroleum ether (boiling range 40-60° C.) and the extract estimated. Sodium and potassium were estimated by flame photometry, phosphorus was estimated colorimetrically with Fiske and Subbarow reagent, and chloride by Vohland's method. Sulphur content was determined by precipitation with barium chloride and moisture content by heating the algal powder at 110° C. till a constant weight was obtained.

The results obtained in the present investigation along with the results of Japanese

workers are presented in Table I. The carbohydrate and calcium content of the Indian species are equal to those of the Japanese species but the protein and phosphorus contents are comparatively lower. The nutritional value of the local *Porphyra* can however be regarded as quite good. It will, therefore, be worthwhile to consider the large-scale cultivation of this species in this country.

TABLE I

Chemical composition of *Porphyra* species from Virakhaputnam coast of S. India and comparison with Japanese species  
(g. per 100 g. of air dried material)

Sl. No.	Constituents	Percentage on dry weight basis	
		Indigenous species	Japanese species
1.	Moisture	.. 3.10	11.40
2.	Soluble sugars	.. 3.16	4.70
3.	Starch	.. 36.30	39.60
4.	Crude protein	.. 16.01	35.60
5.	Crude fat	.. 0.70	0.70
6.	Ash	.. 9.54	8.00
7.	Insoluble substances	.. 1.95	..
8.	Sodium	.. 5.66	..
9.	Potassium	.. 1.11	..
10.	Calcium	.. 0.30	0.26
11.	Magnesium	.. 0.45	..
12.	Chloride	.. 3.58	..
13.	Phosphorus	.. 0.10	0.51
14.	Sulphur	.. 0.11	..

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1. Boney, A. D., *Adv. Mar. Biol.*, Academic Press, London, 1965, **3**, 105.
2. Kurogi, M., *Fishing News International*, 1963.
3. *Japanese Fisheries*, Asia Kyokai, Tokyo, 1960, p. 55.
4. Sreeramulu, T., *S.S. and Cult.*, 1952, **18**, 285.
5. Umamaheswararao, M. and Sreeramulu, T., *Curr. Sci.*, 1963, **32**, 173.
6. and —, *J. Ecol.*, 1964, **52**, 595.
7. Boergesen, F., *J. Ind. Bot. Soc.*, 1937, **16**, 311.
8. Tamiya, H., *Proc. of the Symposium on Algology*, Indian Council of Agricultural Research, New Delhi, 1959 (Published 1960), p. 379.

## ON THE NATURE AND ORIGIN OF CARBONACEOUS MATERIAL FOUND IN THE SYLHET TRAP\*

THE note records, for the first time, a carbonaceous material within the basalt flows of the Sylhet Traps and discusses its origin. The material is exposed along a cliff section at Dewasaw (25° 13' 40": 91° 37' 00"), Khasi Hills. It is a sub-horizontal lenticular patch, 1 m. in length and 0.1 m. in maximum thickness with no associated intertrappean sediments.

The carbonaceous material is friable, breaking into black vitreous fragments showing conchoidal fracture. Spherical cavities are ubiquitous.

Thin section study reveals reddish-brown vitrified ground-mass showing indistinct wood structure, and, under high magnification, a few oval-shaped bodies resembling resin. High ranking micro-constituents are absent. The mineral grains are nodular. The presence of resin-like bodies and the woody structure suggest derivation from plant material.

An analysis of the material by the Regional Research Laboratory at Jorhat showed: Moisture 18.3%, volatile matter 37.4%, and fixed carbon 62.6%, and with calorific value of 6040 cal. Kg. The ultimate analysis gave hydrogen 3.3% and oxygen 22.6% and carbon 72.8%.

Its low carbon and high oxygen contents correspond neither to coal nor to natural coke. It differs from lignite in having low volatile and hydrogen contents, but it is comparable to lignite in its carbon and oxygen contents. Sulphur, present in the sample, is apparently of organic origin as pyrite is absent.

The nature of its occurrence in the field, its petrographic characters and the chemical analysis represent that the carbonaceous material is of woody origin evidently formed from a log of wood which was completely engulfed in the lava flows when it was charred by the heat of the flow in total absence of air. Together with the rarity of intertrappean sediments in the Sylhet Trap, this carbonaceous material of woody origin indicates that these sub-aerial basalts were erupted rapidly; this contrasts with the Rajmahal Traps (considered coeval of Sylhet Traps) in which intertrappean beds with well-preserved plant impressions are known.

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Sanyal for the microscopic study and to Shri B. B. Barua for the chemical analysis.

Geological Survey SUHAS CHANDRA TALUKDAR.  
of India,  
Assam Circle, April 17, 1967.

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### A NOTE ON THE ORIGIN OF ALBITE IN GRANITE

THE origin of albite which occurs as rims and granules at plagioclase-potash feldspar interfaces in granitic rocks is a matter of controversy. Phemister (1926) and Ramberg (1962) contend that the albite is formed by unmixing of potash feldspar, while Rogers (1958 and 1961) demonstrates that it has been derived from a fluid phase formed synchronously with the associated potash feldspar during the later stages of magmatic solidification. During the detailed mineralogical and petrological work on the rocks of Mid Pennar Reservoir (M.P.R.) project area in Anantapur District of Andhra Pradesh, this common feature has been found to develop by various mechanisms. One such mechanism is described here.

The granite under study is composed of quartz (29.9%), microcline (24.3%), microcline micropertthite (9.8%), plagioclase (30.4%: An: 22%), epidote (2.1%) and accessories (0.8%). Plagioclase (An: 20%) occurs as broad plates with polysynthetic twinning and a few show compositional zoning. They are highly turbid owing to sericitic alteration. Epidote occurs as irregular grains, non-pleochroic, with  $2V_x = 78^\circ$ .

Though the rim albite or granular albite is most commonly seen either at the contact between potash feldspar and plagioclase or within potash feldspar, in the present study the albite rim is found around the plagioclase which is not in contact with microcline or microcline micropertthite, but is in contact with epidote and quartz (Fig. 1). The sodic rim, in contrast to the host plagioclase, is very fresh with polysynthetic twinning. The plagioclase has numerous, closely spaced twinning lamellae, while in the rim the lamellae are relatively broader and are coaxial with those of the basic plagioclase (Fig. 2). The rim is pure albite with maximum extinction  $16.5^\circ \perp [010]$ . In explaining the origin of albite, the association of epidote with plagioclase which is surrounded by sodic rim is significant.

The presence of a discontinuity between albite to oligoclase compositions in plagioclase has been observed under various environments. Christie (1959), Brown (1960), Rutland (1961) and Noble (1962) have attributed this discontinuity, in the composition of plagioclase, to the unmixed constitution of these plagioclases. The more calcium-rich phase of such feldspar is unstable in the presence of water and excess calcium, and the reaction:

Calcium plagioclase  $\rightleftharpoons$  albite + epidote  
is favoured when the temperature reaches a

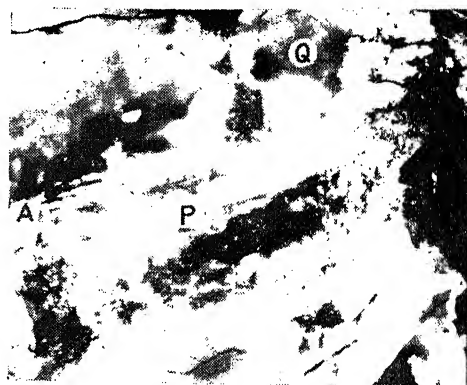


FIG. 1



FIG. 2

FIGS. 1-2. Crossed Nicols. Fig. 1,  $\times 45$ . Fig. 2,  $\times 75$ .  
Q, Undulant quartz; P, Basic, sericitised Plagioclase;  
A, Fresh albite; E, Granular epidote.

point at which the velocity of the reaction attains a geologically finite rate. But due to inadequate knowledge of the sub-solidus relations of the plagioclase, this equilibrium between plagioclase and epidote has not been used as a general geologic thermometer. However it provides one of the clues for the origin of albite. The association of plagioclase and epidote, and occurrence of albite surrounding

the plagioclase which is not in contact with microcline but with epidote, suggest that the normal more basic plagioclase has suffered decalcification in the presence of water, producing albite and epidote. Thus the albite is regarded as secondary, in the sense that it has been formed after the major process of formation of granite. This mechanism of the origin of albite offers explanation for another important aspect.

M.P.R. granite is of magmatic origin (Prasad), and hence the host rock is expected to suffer contact metamorphic effects transforming into much higher temperature mineral facies than they are now observed to be. But no such effects are discernible. It is believed to be due to retrogressive metamorphism, such as decalcification of more basic plagioclase and the consequent development of albite and epidote, that has altered the host rocks consistently to a lower grade, probably altering all traces of earlier contact metamorphic effects that are expected to be seen in the country rock consequent to the intrusion of granitic magma.

Grateful thanks are due to Prof. M. G. C. Naidu for helpful suggestions.

Department of Geology, E. A. V. PRASAD.  
Sri Venkateswara Univ.,  
Tirupati (A.P.), November 14, 1967.

1. Brown, W. L., *Zeit. Krist.*, 1969, **113**, 330.
2. Christie, O. H. T., *Norsk Geol. Tidsskr.*, 1959, **39**, 268.
3. Noble, D. C., *Jour. Geol.*, 1962, **70**, 234.
4. Phenister, J., *Scotland Geol. Surv. Mem.*, 1926.
5. Prasad, E. A. V., *Ind. Mineralogist* (Under publication).
6. Ramberg, H., *N. Jb. Mineral abh.*, 1962, **98**, 14.
7. Rogers, J. J. W., *Geol. Soc. Amer. Bull.*, 1958, **69**, 449.
8. , *Amer. Jour. Sci.*, 1961, **259**, 186.
9. Rutland, R. W. R., *Ibid.*, 1961, **259**, 76.

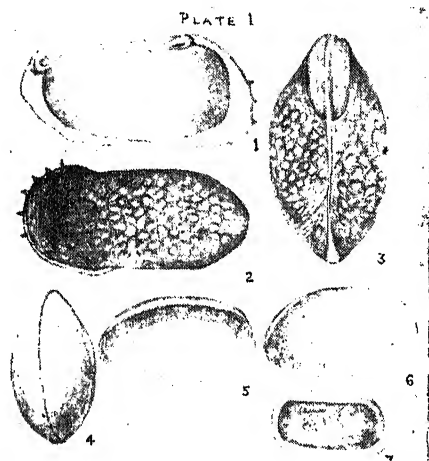
#### OSTRACODA FROM THE KOPILI FORMATION (UPPER EOCENE) OF ASSAM

This note records the occurrence of three genera of Ostracoda from the Kopili Formation (Upper Eocene) of Assam.

During the months of March/April 1967 the writer made a systematic collection of twenty-one microfaunal samples from a uniform and continuous section of marine shales with the view of carrying out detailed micropaleontological and paleoecological investigations. The shales are exposed along a footpath leading

from the Inspection bungalow at Rongrenggiri (Garo Hills) in the north to the bank of the Simsong River in the south-east.

The study of the washed and dried fractions of the soft, calcareous grey-coloured shales revealed the presence of some ostracodes in addition to smaller foraminifera. The Ostracodes (Figs. 1-7) in the samples are frequent



FIGS. 1-7. *Trachyleberis*. Figs. 1-3. *Cytherella protuberantis* Lubimova and Guha. Figs. 4-6. *Cytherelloidea* sp. aff. *C. tewarii* Bold. All Figs.,  $\times 75$ .

to infrequent and mostly in a good state of preservation. The three forms of Ostracodes which are more common, are tentatively referred to as:

1. *Cytherella protuberantis* Lubimova and Guha (family: Cytherellidae).
2. *Cytherelloidea* sp. aff. *C. tewarii* Bold (family: Cytherellidae).
3. *Trachyleberis* (family: Trachyleberidae).

The forms referred to as *Cytherella protuberantis* Lubimova and Guha and *Cytherelloidea* sp. aff. *C. tewarii* Bold closely resemble the forms described by Guha (1965) from Middle to Upper Eocene samples of Cambay, Gujarat State, Western India.

On the basis of the occurrence of the associated planktonic foraminifera, viz., *Pseudohastigerina micra* (Cole), *Chiloguembelina cubensis* (Palmer), *Turborotalia aculeata* (Jenkins), and *Turborotalia* cf. *gemma* (Jenkins); the samples containing these Ostracodes have been assigned an early Upper Eocene age (Srinivasan and Srivastava, 1967).

A detailed study of the Ostracoda present in this material of the Kopili Formation is under progress.

Department of Geology, S. S. SRIVASTAVA.  
Banaras Hindu University,  
Varanasi-5, December 5, 1967.

1. Guha, D. K., *Jour. Geol. Soc. India*, 1965, **6**, 143.
2. Srinivasan, M. S. and Srivastava, S. S., *Seminar on the Geology of North-eastern India, Shillong, Abstracts*, 1967, **19**, 14.

### 'WORM BURROWS' IN NARJI LIMESTONES, NEAR GOVINDINNE, KURNOOL DIST., A.P.

THE occurrence of worm casts in Narji limestones of the Jammalamadugu Series of the Kurnool System has not been reported so far, although it has been known from the time King (1872) in his classic Memoir has stated that the Kurnools are quite suitable to hold fossils of such burrowing creatures. Sreenivasa Rao (1943) has reported the occurrence of algal structure in the Cuddapah limestones. Vaidyanadhan (1961) has reported the presence of stromatolites in Vempalli dolomites. Vijayam (1965) studied the stromatolites near Venkatagiri, Kurnool District, in Vempalle dolomites (see also Logen *et al.*, 1964).

Narji stage in this area has four types of limestones—grey massive, white massive, dark massive and dark flaggy. Several worm-like moulds of pyrite and pyriteferous shales occur in a 2-metre thick horizon within the white massive limestones on the southern slope of a hillock 200 metres west of Govindinne village, 9 km. north of Banganapalli, Kurnool District. The worm burrow moulds have sizes varying from 5 to 20 cm. and about 1-2 cm. in diameter. The moulds are slightly curved and show some segments (Fig. 1). On



FIG. 1. 'Worm burrows' filled up by authigenic pyrite in Narji Limestones.

the bedding planes of these white massive limestones, just below the beds having worm

burrows, some organic structures, discoidal in shape with concentric bands ranging in size from 1-5 cm. are found in grey massive limestone. Some of the worm burrows are filled in by authigenic pyrite with iron oxide coating on them.

The orthoquartzite-carbonate association in this part of the basin indicates a stable shelf, platform tectonic element and shallow water environment under which the sediments were deposited. About one mile south of this area at the base of Narjis a thin bed of intraformational conglomerate of limestone pebbles with calcareous and shaly matrix is observed. Farther south angular pebbles of dark massive limestone are found in crystalline limestone. Such occurrences indicate that the carbonate sedimentation in this area had taken place in shallow waters. This replacement of the burrows by authigenic pyrite has helped the preservation of the burrows during the lithification. The occurrence of the worm burrows in the Kurnools provides evidence of existence of invertebrates in this period and supports the correlation of these formations with uppermost Proterozoic or even Lower Cambrian.

Thanks are due to Mr. G. Venkatarama Reddy for collecting some of the specimens. The author expresses his thanks to Prof. M. S. Krishnan for his advice and discussion during the investigation of this work.

Geology Dept., B. E. VIJAYAM.  
Osmania University,  
Hyderabad, October 6, 1967.

1. King, W., "The Kadapah and Kurnool formations in the Madras Presidency," *Mem. G.S.I.*, 1872, **8**, 37.
2. Logan, B. W., Rezak R. and Ginsburg, R. N., "Classification and environmental significance of algal stromatolites," *Jour. Geol.*, 1964, **72**, 68.
3. Sreenivasa Rao, M. R., "Algal structures from the Cuddapah limestones (Pre-Cambrian)," *Curr. Sci.*, 1943, **12**, 207.
4. Vaidyanathan, R., "Stromatolites in lower Cuddapah limestones (Pre-Cambrian) in Cuddapah Basin," *Ibid.*, 1961, **30** (6), 221.
5. Vijayam, B. E., "Sedimentation in the Upper Proterozoic near Kurnool," *Ph.D. Thesis* (unpublished), 1965.



# FUNCTIONAL MORPHOLOGY OF ADULT HAPTOR IN AXINIDAE (MONOGENEA)

HAPTOR in Monogenea is important both functionally and taxonomically. In the adult haptor of higher Monogenea, clamps are added in the antero-posterior axis either on both sides or on one side only. In forms having clamps on one side, it is as a result of suppression of clamps on the other side. This suppression is either a primary phenomenon as in *Gastrocotyle*, inferred from observation on juvenile *G. trachuri* with 3 clamps (Llewellyn<sup>1</sup>) or is a secondary phenomenon as in *Monaxine* wherein clamp addition takes place upto 4 clamps on both sides, but subsequently no further addition takes place on the suppressed side and even the developed clamps on this side are lost (Ramalingam<sup>2</sup>). Whether suppression is primary or secondary, addition of clamps is either parallel or oblique to the long axis of the body with formative zone directed forwards thus facilitating addition of clamps with growth.

In axinids, the adult haptor, though it has two rows of clamps, appears as having a single row of clamps owing to their tandem position with an end-to-end arrangement and is oblique to the long axis of the body. The anchor-bearing languette, representing the morphological posterior end of the worm, is situated medially and this position roughly corresponds to the distal end of an imaginary line passing through median longitudinal axis of the body. The anchor-bearing languette by its position in the adult is suggestive of suppression of the median growth axis of the haptor and it is not known whether it is as a result of primary or secondary suppression.

Direct evidence is now obtained from juvenile *Axinoides* with 2/2 clamps (obtained from gills of marine fish, *Tylosurus tieurus* (Bleeker) which not only confirms the presence of suppression of the median growth axis of the haptor, an inference drawn from the position of anchor-bearing languette medially in the adult haptor, but also reveals that suppression is primary. As a result, clamps come to lie in a line oblique to the long axis of the body even from this stage onwards.

Moreover this specimen and specimens having 6/6 and 8/9 clamps from the same host species reveal certain features regarding the position of the formative zones of the two clamp rows as well as mode of addition of clamps which are at variance with the findings of Unnithan.<sup>3</sup>

He states, "the formative field for right and left clamps is on each side proximal to the larval termination as should be for functional reasons and since the growth in length of the haptoral axis is completely inhibited, the older clamps are pushed out laterally as more are developed in the formative zone". On the contrary, the formative zones of the two clamp rows as revealed by these specimens [(by the presence of incipient clamps (*i.cl.*) and clamp anlagen (*cl.a.*)] show that they are directed forwards with the result the formative zone of the row of clamps behind the anchor-bearing languette is close to it, whereas the formative zone of the clamp row anterior to it is away from it (Fig. 1). The disposition of the formative zones of the clamp rows both pointing in the same direction forwards would functionally facilitate addition of clamps with growth.

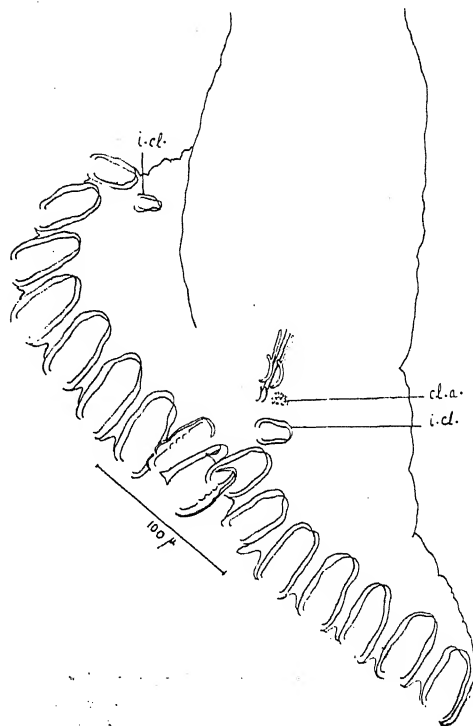


FIG. 1. Haptor of *Axinoides* (Dorsal view). Formative zones of right and left clamp rows in relation to anchor bearing languette. (*cl.a.*, clamp anlagen; *i.cl.*, incipient clamp.)

In higher Monogenea clamp addition takes place from the level of posteriormost pair of marginal hooklets found in lateral wing-like expansions of post-oncomiracidial haptor.

(Ramalingam<sup>4</sup>). Hence it is of interest in the context to compare the haptor of oncomiracidium of *Axine* described by Bychowsky<sup>5</sup> and Euzet,<sup>6</sup> the haptor of post-oncomiracidium of *Axinoides* (collected along with juveniles, immature and adult *Axinoides* from this host species) with the haptor of post-oncomiracidium of *Pricea* and *Monaxine* (Ramalingam<sup>2,4</sup>) which reveals that in all these the haptor is bilaterally symmetrical. If the addition of clamps were to take place as in *Pricea* spp. (Ramalingam<sup>4</sup>) from the level of the posteriormost pair of larval hooklets, it is of interest to know how and in what manner formative zones of the bilaterally symmetrical haptor originally directed parallel to the long axis of the body become shifted obliquely either to right or left of the body during the transition from the post-oncomiracidial larva to juveniles with clamps.

The different stages in the development as represented by specimens with 2/2 clamps to 11/20 clamps in the haptor reveal that acquisition of clamps in the two rows is different and the sides having greater number of clamps also vary. Moreover, the position of the anchor-bearing languette with reference to clamp number from the hind end of worm also varies. These and other features of interest together with a description of post-oncomiracidium, juvenile, immature and adult *Axinoides* will be published elsewhere.

My thanks are due to Dr. G. Krishnan, Director, Zoology Laboratory, for interest and encouragement.

Zoology Laboratory, K. RAMALINGAM.  
University of Madras,  
Chepauk, Madras-5, December 5, 1967.

1. Llewellyn, J., *J. mar. biol. Ass., U.K.*, 1959, **38**, 461.
2. Ramalingam, K., *Annals & Mag. Nat. Hist.* (1960), 1961, Ser. 13, **3**, 699.
3. Unnithan, R. V., *Bull. Central Res. Inst., University of Kerala*, Ser. C, Nat. Sci., **5** (2), 27.
4. Ramalingam, K., *Proc. Natl. Inst. Sci. India*, 1960, **26** (6), 352.
5. Bychowsky, B. E., *Monogenetic Trematodes, Their Classification and Phylogeny*, (Trans. Hargis, W. J., 1961), American Institute of Biological Sciences, Washington, 1957, p. 627.
6. Euzet, L., *Bull. Soc. Neuchâtel Sci. nat.*, 1955, **78**, 71.

## A NOTE ON RECORD OF *COMPSOPOGON COERULEUS* MONT. FROM GUJARAT

OUT of eight species of *Compsopogon* so far known to science three have been recorded from India.<sup>2</sup> They are *Compsopogon caeruleus* (Balbis) Mont., *C. hookeri* Mont. [Syn. *C. lividus* (Hooker) de Toni] and *C. iyengarii* Krishnamurthy. Das, however, mentions that Indian *Compsopogons* are: *C. caeruleus* Mont., *C. lividus* (Hooker) de Toni and *C. indicus* Das.<sup>1</sup>

*C. iyengarii* Krishnamurthy is the only species previously recorded from Gujarat.<sup>3</sup> In this paper *C. caeruleus* (Balbis) Mont. collected near Lunawada (Panchmahal District of Gujarat State) is described.

*Compsopogon caeruleus* (BALBIS) MONT. 1946

Thallus greenish-blue; attached to substratum by hold-fasts, about 15 to 40 cm. long. Main axis robust, about 1 mm. in diameter, tapering gradually towards the apex, corticate: central cells of the main axis large, surrounded by small polygonal cells; Branches many, multiseriate; distal ones uniseriate; cells of uniseriate branches discoid, 20–30  $\mu$  in width, 8–15  $\mu$  long. Only immature monosporangia observed.

The plant was collected from a pool near a river at Lunawada in December 1965.

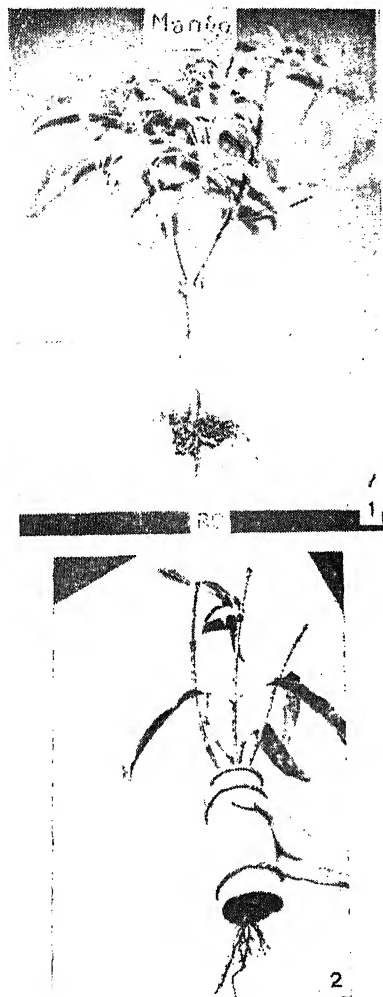
Botany Department, B. S. VAIDYA.  
Gujarat University,  
Ahmedabad-9, July 11, 1967.

1. Das, C. R., *Proc. Nat. Inst. Sci. India*, 1963, **29 B**, 239.
2. Krishnamurthy, V., *J. Linn. Soc. (Bot.)*, 1962, **58**, 207, 372.
3. Patel, R. J., *Curr. Sci.*, 1965, **34**, 614.

## ROOTING OF MANGO CUTTINGS UNDER MIST

ATTEMPTS at propagation of mango (*Mangifera indica* Linn.) by cuttings have been made for more than a quarter of a century with little success notwithstanding encouraging effects of chemicals and pretreatments like ringing and etiolation on rooting of juvenile and invigorated shoots.<sup>1–5</sup> Mukherjee *et al.*<sup>4</sup> while successfully inducing rooting in cuttings from young mango plants found that cuttings from one-month old seedlings gave the highest percentage of rooting, but with increasing age of mother plants rooting was considerably reduced. They concluded: "At present it does

not appear to be possible to raise cuttings of mango directly from mature plants." In experiments under intermittent mist that have been taken up in this laboratory during past one year, ringed hard wood shoot cuttings of mature mango plants have been found to root successfully (Fig. 1).



FIGS. 1-2. Fig. 1. Rooted mango cutting sixty days after planting. Fig. 2. Earthenware split pot showing roots coming out of the bottom slit.

One, two and three years old shoots on a 35-year old grafted mango tree (var. Himsagar), in full vigour and good bearing condition, were ringed in early June, 40-60 cm. from tip, depending on age of shoot. After 40 days the shoots were detached from the mother plant by giving a sharp slant cut through the callused region above the girdle.

The cuttings of each age group were treated in two ways, (i) control—"RC" planted as such and (ii) "RIBA" treated with IBA (2000 ppm quick dip followed by 5000 ppm in talc) before planting, in a 1:1 sand and moss mixture, in specially designed earthenware pots 20 × 8 cm., longitudinally split in two equal halves, held together with coir string (Fig. 2). This split pot device facilitated periodical observation on progress of rooting and transplanting of the rooted cuttings without much damage to the young roots. The pots were placed half sunk in sand in concrete propagation frames, fitted with automatic mist control unit, in a glass house. Sixty days after planting the cuttings were finally taken out and observations on their rooting performance made. The data are summarised in Table I.

TABLE I

Data on root formation in cuttings of three different categories of shoots (average of 20 cuttings under each category of shoot in case of RC, and of 10 cuttings per category in case of RIBA)

Treatment	Category of shoots	Percentage of cuttings rooted	No. of main roots per rooted cutting	Dry weight of roots per rooted cutting (in gm.)
RC	1-yr. old shoot	40	2.0 ± 0.35	1.00 ± 0.16
	2 " "	60	3.5 ± 0.20	2.08 ± 0.08
	3 " "	70	3.7 ± 0.17	2.20 ± 0.20
RIBA	1 " "	50	2.0 ± 0.28	1.60 ± 0.21
	2 " "	60	4.0 ± 0.15	2.30 ± 0.14
	3 " "	80	3.8 ± 0.15	3.00 ± 0.13

In the present experiment cuttings from the older shoots have generally indicated better rooting which might be due to relative abundance of foliage in the older shoots of relatively bigger sizes resulting in enhanced beneficial effect of ringing. Earlier studies by Guhathakurta and Dutta,<sup>1</sup> Gardner and Piper<sup>2</sup> and Mukherjee *et al.*,<sup>3,4</sup> however, showed that cuttings from young and juvenile plants rooted better. They did not study rooting response of cuttings from shoots of different age from the same mature mother plant. Preliminary observations made in this laboratory (unpublished) indicate that under outdoor conditions older shoots (2-3 year old) with large foliage desiccate more quickly than young one-year old shoots with lesser number of leaves. It is considered that under intermittent mist when desiccation is prevented the larger foliage of

older shoots exert greater root-promoting effects.

The results definitely indicate the possibility of clonal propagation of mango cuttings under mist.

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Department of Agriculture, P. K. SEN.

Calcutta University, R. N. BASU.

35, Ballygunge T. K. BOSE.

Circular Road, N. ROYCHOUDHURY.

Calcutta-19, October 10, 1967.

1. Guhathakurta, A. and Dutta, B. K., *Curr. Sci.*, 1941, 10, :97.
2. Gardner, F. E. and Piper, R. B., *Proc. Fla. St. Hort. Soc.*, 1943, 56, 124.
3. Mukherjee, S. K., Majumder, P. K., Bid, N. N. and Goswami, A. M., *Curr. Sci.*, 1965, 24, 434.
4. —, —, — and —, *J. Hort. Sci.*, 1967, 42, 83.
5. Basu, R. N., Roychoudhury, N., Bose, T. K. and Sen, P. K., *Ind. Agrist.*, 1966, 10, 147.

### THE STOMATA OF *THELIGONUM CYNOCRAMBE* L.

THE genus *Theligonum* (*Cynocrambe* Tourn.) is the sole representative of the family Theligonaceae. It comprises 4 species: *T. japonicum* Kubo and Makino, *T. macranthum* Franch., *T. cynocrambe* L., and *Cynocrambe formosana* Ohwi. Of these, *T. cynocrambe*, the Mediterranean taxon, has attracted much attention (See Schneider,<sup>1</sup> Gregson,<sup>2</sup> Paliwal,<sup>3</sup> and Kapil and Mohana Rao<sup>3</sup>).

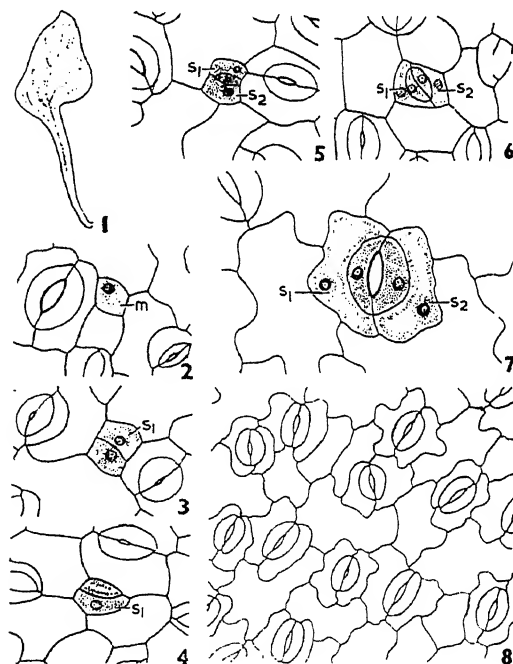
The material on which this investigation is based was collected by the late Professor P. Maheshwari in 1961, from the Botanisches Garten, Institut für Systematische Botanik, Berlin, Germany. Formalin-acetic acid-alcohol was used for fixation.

*T. cynocrambe* is a succulent, monoecious annual. The leaves are borne alternately in the upper region whereas in the lower part of the stem they are opposite. They are petiolate, fleshy and oval with an entire margin (Fig. 1). As reported by Schneider (See also Metcalfe and Chalk<sup>4</sup>), the stomata are rubiaceous and occur on both surfaces of the leaf. The stomatal frequency, per unit area, ranges from 400<sup>3</sup> at the base to 271 in the apical region of the leaf; the Stomatal Index is 29 at the base and 38 at the apex.

The development of the stoma begins with the formation of a transverse septum on one side of a protodermal cell producing two unequal cells (Fig. 2). The smaller one functions

as a meristemoid and these are irregularly scattered.

The meristemoid (*m*) enlarges and divides transversely or diagonally to the long axis of the initial. The daughter cells are unequal (Fig. 3) and the larger becomes the first subsidiary cell (*S*<sub>1</sub>). The smaller cell again divides unequally and the larger daughter cell forms the second subsidiary cell (Fig. 4; *S*<sub>2</sub>). Now a row of three cells can be recognized (Fig. 5); the central cell functions as the guard mother cell. At first it is smaller than the lateral cells but later enlarges and divides vertically and unequally and the daughter cells function as guard cells (Fig. 6). The two subsidiary cells are distinguishable from the other epidermal cells by their lateral position and smaller size. The mature stomata (Figs. 7, 8)



FIGS. 1-8. *Theligonum cynocrambe*, development of stomata (*m*, meristemoid; *S*<sub>1</sub>, *S*<sub>2</sub>, subsidiary cells). Fig. 1. Entire leaf, × 4. Figs. 2-7. Ontogeny of stomata, × 176. Fig. 2. A meristemoid. Fig. 3. Division of meristemoid to cut off the first subsidiary cell (*S*<sub>1</sub>). Fig. 4. Smaller daughter cell of the meristemoid in division. Fig. 5. Advanced stage, note the subsidiary cells and median guard mother cell. Figs. 6, 7. Young and mature stomata. Fig. 8. Epidermal peel showing distribution of paracytic stomata, × 83.

are, therefore, of the paracytic type. Since the guard cells and two subsidiary cells originate from the same meristemoid, the development conforms to the syndetocheilic

type of Florin<sup>1</sup> and mesogenous type of Pant.<sup>6</sup>

I am grateful to Professor B. M. Johri for encouragement.

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University of Delhi,  
Delhi-7, October 14, 1967.

\* Means of 5 readings.

1. Florin, R., *K. svenska Vetensk Akad. Handl.*, 1931, 10, 1.
2. Gregson, N. M., *Nature*, London, 1963, 200, 917.
3. Kapil, R. N. and Mohana Rao, P. R., *Proc. Natl. Inst. Sci. India*, 1966, 32 B, 218.
4. Metcalfe, C. R. and Chalk, L., *Anatomy of the Dicotyledons*, Clarendon Press, Oxford, 1950.
5. Paliwal, G. S., *Proc. 50th Indian Science Congr.*, 1963, Part III, Abstr., 388.
6. Pant, D. D., *Pl. Sci. Ser.*, 1965, 1, 1.
7. Schneider, H., *Fiera*, 1914, 106, 1.

#### A NEW RECORD OF *CHAETOMELLA* *CIRCINOSETA* FOR INDIA

*Chaetomella circinoseta* Stolk (Fig. 1) in *Trans. Brit. mycol. Soc.*, 1963, 46 (3): 413.

COLONIES on potato dextrose agar in petri dishes grow well, with colourless submerged mycelium and pale to dark brown aerial mycelium. The pycnidia formed on the surface of the medium, singly or in clusters of 5-8 are brown to dark brown, subglobose to ellipsoid, 257.5-486.0  $\mu$  long, 170.0-243.0  $\mu$  high, with the typical raphe and beset with brown, rigid setae. Long setae, which are straight but ending at the tip in distinct coils are light brown to brown, septate but with indistinct septa, 130.25-334.75  $\mu$  long, 5.5  $\mu$  broad at base gradually tapering to 3.75-4.50  $\mu$  towards the tip, rough and thick-walled. Small setae are straight, thick-walled, rough 1-4 septate, brown, 46.50-130.25  $\mu$  long, 3.75-5.5  $\mu$  broad at base and 4.50-7.50  $\mu$  broad at the tip, which is hyaline to subhyaline and club-shaped. The long setae have mostly inconspicuous septa which require very careful observation for ascertaining their presence. The pycnidial wall is thick and composed of brown to dark brown cells with somewhat thick walls 4.50-5.50  $\mu$  in diameter. From the basal part of the inner wall arise the hyaline, filamentous, irregularly branched conidiophores which are 16.75-37.25  $\mu$  long and 1.25-2.0  $\mu$  broad, each ending in a 50.0-130.25  $\mu$  long sterile filament, which is unicellular, straight or curved. The conidia, borne apically, are hyaline, continuous, cylindrical to naviculate, 7.5-11.25  $\mu$  long and 1.75-2.25  $\mu$  broad, with 1.25-1.75  $\mu$  thick mucoid cap at each end. Spore release occurs through rupture of the pycnidial wall along

the raphe. The spores ooze out in slimy drops which are cream-coloured at first but became amber with age. The pycnidia are attached to the substratum by a pseudoparenchymatous light brown to brown stipe, 73.0-97.25  $\mu$  long and 24.25-39.0  $\mu$  high.

Isolated from dead leaves of *Syzygium jambos* Alston, October 12, 1967. Chaliyam (Kerala State). K. M. Ponnappa. Herb. IMI. 130713.

The species here described agrees closely with *Chaetomella circinoseta* Stolk in possessing two types of the setae: long setae with septa indistinct at first and ending in a few coils and short club-shaped setae, but with minor differences in the magnifications in the dimensions of the structures which may be considered to fall within the limit for the species. The collection is, therefore, best placed in *Chaetomella circinoseta* Stolk.

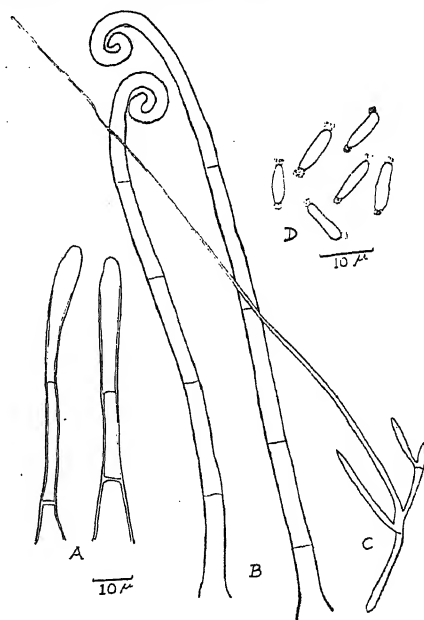


FIG. 1. *Chaetomella circinoseta* Stolk. A, Short club-shaped setae. B, Long and coiled setae. C, Conidiophore and sterile filament and D, Conidia.

We are grateful to Dr. V. P. Rao, Entomologist-in-charge, for his keen interest, constant encouragement and for according permission to publish this brief note.\*

Commonwealth Institute of K. M. PONNAPPA.  
Biological Control, T. R. NAG RAJ.\*\*  
Indian Station,  
Bangalore-6 (India),  
December 13, 1967.

\* We are thankful to Dr. E. Panithalingam, C.M.I., England, for confirming our identification.

\*\* Present Address: Department of Botany, University of Waterloo, Waterloo, Ont., Canada.

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## REVIEWS AND NOTICES OF BOOKS

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1966 Tokyo Summer Lectures in Theoretical Physics.

Part I. Dynamical Processes in Solid State Optics. Edited by R. Kubo and H. Kammura. (Syokabo Publishing Company, Tokyo and W. A. Benjamin, Inc., New York), 1967. Pp. vii + 245.

Part II. Elementary Particle Physics. Edited by Gyo Takeda and Akihiko Pujii. (Syokabo and W. A. Benjamin, Inc., New York), 1967. Pp. vi + 209.

The Second Tokyo Summer Institute of Theoretical Physics was held, like the first, in two sections in the year 1966.

Part I contains the texts of the following ten principal lectures delivered: Optical Properties of a Dielectric Medium, by E. Burstein; Raman Scattering Phenomena, by E. Burstein; Plasma and Magneto-Plasma Phenomena in Solid State Optics, by J. Bok; Dielectric Dispersion in Solids, by Tatsumi Kurosawa; Vibration-Induced Structures in the Absorption Spectra of Localized Electrons in Solids, by Yutaka Toyozawa; Effects of Electron-Electron Interactions on the Optical Properties of Metals, by J. J. Hopfield; Elastic Scattering at Inelastic Thresholds Application to Solids, by J. J. Hopfield; Optical Spectra of Solids, by J. C. Phillips; Dynamics of Nonlinear Interaction between Radiation and Matter, by H. Haken; and Quantum Theory of Noise in Masers and Lasers, by M. Lax.

Part II contains the texts of the following twelve lectures delivered: Some Recent Works on Regge Poles and the Three-Body Problem, by Stanley Mandelstam; Regge Pole Phenomenology at High Energies, by B. M. Udgankar; New Experimental Evidence on Regge Poles in High Energy Scattering, by Steven C. Frautschi; Comparisons Between On-shell and Off-shell Methods for the Two-body T-matrix, by D. Y. Wong; Quark Substructure for Mesonic and Baryonic States, by R. H. Dalitz; Models of Hadrons, by Susumu Okubo; Axial-Vector Current Consisting of Pseudo-Scalar Octet, by Masso Sugawara; Lie Group of the Strong Coupling Theory, by B. M. Udgankar; SU(6) and the Bootstrap Hypothesis, by Tichard H. Capps; Standing Problems in Weak Interactions and CP-Violation, by

Louis Michel; "Elementary-Particle" Theory of Nuclear Beta Decay and Muon Capture, by Henry Primakoff; and Particles and Sources, by Julian Schwinger. C. V. R.

Advances in Astronomy and Astrophysics (Vol. 5). Edited by Zdenek Kopal. (Academic Press, New York and London), 1967. Pp. xi + 355. Price \$50.55.

Volume 5 of this well-known series contains the following articles: The Zodiacal Light, by D. E. Blackwell, D. W. Dewhirst and M. F. Ingham; Three-Dimensional Periodic Oscillations about  $L_1$ ,  $L_2$ , and  $L_3$ , by T. A. Bray and C. L. Goudas; Secular Variation of Mass and the Evolution of Binary Systems, by John Hadjidemetriou; The Periodicity of the Sunspot Groups, by Milošlav Kopecký; and Compact and Dispersed Cosmic Matter, Part I, by F. Zwicky. C. V. R.

Newer Methods of Nutritional Biochemistry (Vol. III)—*With Applications and Interpretations*. Edited by A. A. Albanese. (Academic Press, New York and London), 1967. Pp. xv + 527. Price \$18.50.

This volume is the third in a series devoted to the presentation of improved biochemical procedures that apply to nutrition research and to analyses of basic and practical problems of nutrition in the light of chromatographic and enzymatic techniques.

Volume III discusses areas not previously covered and expands the scope of earlier subject-matter. Emphasis is given to related aspects of protein nutrition and the need for simple procedures to evaluate utilization of dietary proteins. This work will be of special interest to biochemists, nutritionists, medical researchers, clinical chemists, food scientists and graduate students in public health science.

The contents of this volume are: Urinary Excretion of Amino Acids; Nutritional Aspects of Protein Reserves; *In vitro* Protein Evaluation; Availability of Plant Proteins; Lipoprotein Transport; Chemical Assay of Adrenocorticosteroids; Studies of Zinc Metabolism; Foliates in Human Nutrition; and Functional Evaluation of Nutritional Status: Thiamine.

C. V. R.

**The Origin of Continents and Oceans.** By Alfred Wegener. (Translated from the Fourth Revised German Edition by John Biram). (Dover Publications, Inc., New York), 1966. Pp. x + 246. Price \$2.00.

This Dover edition, first published in 1966, is a new English translation of the 1962 printing of the fourth revised edition of *Die Entstehung der Kontinente und Ozeane*, published in 1929 by Friedr. Vieweg and Sohn. It is published by special arrangement with Friedr. Vieweg and Sohn, Braunschweig.

The contents of this book are: Historical Introduction; The Nature of the Drift Theory and Its Relationship to Hitherto Prevalent Accounts of Changes in the Earth's Surface Configuration in Geological Times; Geodetic Arguments; Geophysical Arguments; Geological Arguments; Palaeontological and Biological Arguments; Palaeoclimatic Arguments; Fundamentals of Continental Drift and Polar Wandering; The Displacement Forces; Supplementary Observations on the Sialsphere; and Supplementary Observations on the Ocean Floor. C. V. R.

**The Theory of Equilibrium of Elastic Systems and Its Applications.** By Carlo Alberto Pio Castigliano. (Dover Publications, Inc., New York), 1966. Pp. lxiv + 399. Price \$3.00.

This Dover edition, first published in 1966, is an unabridged and corrected republication of the work originally published by Scott, Greenwood and Son, London, in 1919 under the title *Elastic Stresses in Structures*. This edition also contains a new Introduction and a biographical portrait section prepared especially for this edition by Gunhard A. E. Oravas.

This book is Castigliano's major treatise and it is still among the more penetrating expositions of structural mechanics based upon the principle of work. It was first published in 1879, but the English translation, the basis of this enlarged and corrected reprint, did not appear until 1919. Part I covers the theory: framed structures, elastic structures, general equations of the elastic equilibrium of a solid, theory of lattice girders, formulæ for the internal work of different solid bodies, theory of straight beams, of columns, of curved ribs and arches, of composite structures. Part II is devoted to applications: a beam strengthened by 2 tie-rods and a cast iron strut, by 3 tie-bars and 2 cast iron struts; a roof with an

iron truss without tie-rods; an arched roof truss with 1 tie-rod, with several tie-rods; an iron arch bridge with flat springings, with rounded ends; etc. C. V. R.

**Electric and Magnetic Fields.** By Stephen S. Attwood. (Dover Publications, Inc., New York), 1967. Pp. xi + 475. Price \$3.00.

This Dover edition, first published in 1967, is an unabridged and unaltered republication of the third edition which was published in 1956 by John Wiley and Sons, Inc. Further this edition is dedicated to the memory of Stephen S. Attwood, May 29, 1897 to June 8, 1965.

The contents are: Part I. The Electric Field: The Electrostatic Field; Electric Fields of Simple Geometries; Electric Polarization and Induction; Electric Current; Solution by Method of Images; Space Charge. Laplace and Poisson Equations; Mapping Electric Fields; Energy and Forces in Condensers. Part II. The Magnetic Field: The Magneto-static Field; Magnetic Fields of Simple Geometries; Magnetic Production of Voltage; Energy and Forces in an Inductance. Part III. The Ferromagnetic Field: Ferromagnetism; Permanent Magnets; Imaging and Mapping Magnetic Fields. Part IV. Combined Electric and Magnetic Fields: Interactions of Electric and Magnetic Fields. C. V. R.

**Mathematische Grundlagen Der Genetik.** By Von Erna Weber. (Geb. MDN. Veb Gustav Fischer Verlag Jena, Absatzabteilung, 69, Jena, Villengang 2, Postchliessfach 176), 1967. Pp. 464. Price 63.80.

Rapid developments are taking place in the field of genetics. They are profoundly influencing not only biological science but also sociological sciences. Current concept is to regard living organisms as material things and explain their behaviour in terms of laws of physics and chemistry. This shift in the study of genetics from the purely biological to the molecular level involves a thorough understanding of the basic principles of mathematics, especially in the branch of probability and statistical laws and analysis.

The book under review, in the German language; is an excellent single volume text on the subject which provides all the essential foundation knowledge in mathematics required by a student of genetic study and research. The treatment is clear and comprehensive. Applications to various problems like mutation, selection, heredity, population, etc., are

explained in detail. The book contains 73 illustrations, 103 tables and an appendix.

A. S. G.

#### Network Analysis and Transmission Lines.

By George J. Konnelly. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1967. Pp. 339. Price Rs. 15-00.

This book is one of the familiar types coming into the science books market nowadays, of lecture notes being turned into a printed publication so as to form easy teaching guides to demonstrators, and learning guides to examination taking students.

The book, intended for students of telecommunication engineering, is in four parts, namely, Current Circuits; Networks; Transmission Lines; Modern Circuit Analysis. The book is mainly based on 163 worked-out problems with relevant preliminary discussions and working formulæ. There are 443 diagrams.

A. S. G.

#### Royal Institute of Chemistry Monographs:

No. 13, Principles of Osmotic Phenomena.

By J. F. Thain, 1967: Pp. 68. 8 sh.; No. 14, Principles of Colloidal State. By G. D. Parbitt, 1967. Pp. 35 Price 6 sh. (Royal Institute of Chemistry, 30, Russell Square, London, W.C. 1).

The aim of this series of monographs issued by the Royal Institute of Chemistry is to present concise and authoritative accounts of selected well-defined topics in chemistry for the guidance of teachers of chemistry at G.C.E. Advanced level and above. Each monograph gives a clear exposition of the topic and the fundamentals involved in the theory of the subject and its developments. The monographs are handy, indispensable guide books for teachers who aim at bringing instruction to up-to-date levels.

A. S. G.

#### Laboratory Manual of Agricultural Chemistry.

By A. Sankaram. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1967. Pp. 340. Price Rs. 10.

The author during his experience as a teacher and instructor to undergraduate students of agricultural chemistry felt the need for providing instruction sheets to help the students in their practical classes. These sheets carefully prepared to meet the syllabi requirements of

the B.Sc. Agriculture Practical Course were kept corrected and revised in the light of their use by students. The result is a fairly thorough manual of agricultural chemistry which will be welcomed by students of Agricultural colleges. The manual includes experiments on soil chemistry, soil microbiology, manures and fertilizers, irrigation waters, fats and oils, and milk. An appendix contains useful tables of values and constants.

The text is not altogether free from minor mistakes as for example, equation (5) on p. 32, and "for calcium the red line 554 m $\mu$ " on p. 38.

A. S. G.

#### Principles of Statistics (Second Edition). By

M. G. Bulmer. (Published by Oliver and Boyd, 39 A, Welbeck Street, London, W.1), 1967. Pp. 252. Price 27 sh. 6 d.

Written at intermediate level, the book explains in clear language, with the minimum of mathematics, the fundamental principles and the concepts involved in statistics. In cogently arranged chapters, the treatment includes elements of probability theory, various types of distributions like binomial, Poisson and exponential,  $\chi^2$ ,  $t$  and  $F$ , tests of significance and statistical inference, point estimation, and regression and correlation.

The book will be of use to all students, especially biologists, concerned with applications of statistical methods in their work. This second paperback edition contains many additional exercises and problems.

A. S. G.

#### Books Received

*Chemistry* (2nd Edition). By J. A. Elvidge and P. G. Sammes. (Butterworths, Ltd., London W.C. 2), 1966. Pp. xii + 315. Price not given.

*Language, Logic and Mathematics*. By C. W. Kilmister. (English University Press, Ltd., Warwick Lane, London E.C. 4), 1967. Pp. 124. Price 25 sh.

*Principles of Statistics* (2nd Edition). By M. G. Bulmer. (Oliver and Boyd, Tweedle Court, Edinburgh), 1967. Pp. vii + 252. Price 27 sh. 6 d.

*Separation Techniques in Chemistry and Biochemistry*. Edited by R. A. Keller. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1967. Pp. xvi + 415. Price \$ 12.75.



# THE ATMOSPHERE OF THE EARTH \*

SIR C. V. RAMAN

## ABSTRACT

The processes by which the movements at the surface of the earth due to its rotation around the polar axis can influence the atmosphere above are considered in detail. It emerges that the fast-moving areas in the equatorial belt on the surface of the earth play a highly important role in determining the behaviour of the atmosphere. The jet-stream in the sub-tropical regions, the westerly zonal winds in the region of middle latitudes and the easterly surface-winds in the equatorial belt are explained on this basis and shown to stand in close relationship with each other. The winds observed in the polar belt are also discussed and explained.

### 1. INTRODUCTION

IT is proposed in this address to consider the following questions and endeavour to find answers to them. The earth revolves around its polar axis once in every twenty-four hours; does the atmosphere which is a gaseous mantle enveloping the globe rotate with it and in the same manner at all elevations and in all latitudes? What are the considerations which determine the behaviour of the atmosphere in this respect? What are the observable consequences of any differences between the globe and the atmosphere in the speed of their movements around the polar axis? In dealing with these questions we have necessarily to leave out of consideration, the complexities in the behaviour of the atmosphere at various times and at various places which manifest themselves as the phenomena of the weather. It is these latter phenomena and the interpretations of their origin which are the preoccupations of the meteorologist who watches the weather and seeks to forecast the changes in it. But it is not impracticable to regard the manifestations of weather as variations from a standard state of the atmosphere which may be defined as its

average taken over a sufficient range of time and over a sufficiently extended area of the surface of the earth. In other words, we consider the behaviour of the earth's atmosphere in its broadest aspects, taking a global and long-term view of the subject.

### 2. THE ATMOSPHERIC ROTATION BELTS

In dealing with the problems set forth above, it is necessary at the very outset to recognize that the atmosphere which envelops the globe cannot be considered for the present purposes as a single entity. The reason for this is that all the factors which influence or can influence the atmospheric movements vary enormously over the surface of the earth. Among them we may mention particularly the actual speed of movement of the surface arising out of the rotation around the polar axis, as well as the rate at which this speed alters as we move longitudinally along the surface. The insolation by solar radiation and the magnitude of its variation during the year with the seasons are also very different in various regions. The speed of movement as well as the magnitude of the insolation are both functions of the latitude. Hence, and to avoid any suggestion of arbitrariness, we partition the surface by drawing circles of latitude which are equally spaced. We thus

\* Presidential Address to the Indian Academy of Sciences at its Thirty-third Annual Meeting in Madras, 19th December 1967, as subsequently revised and rewritten.

obtain the following areas on the surface exhibiting distinctive features.

*Firstly*, we have the region which we designate as the equatorial belt and which includes the entire area comprised between the circles of latitude  $30^\circ$  north and south of the equator. This forms a single continuous surface which occupies one-half of the entire superficial area of the globe. The speed of movement is a maximum, *viz.*, 465 metres per second at the centre of the belt which is the equator. The speed falls off quite slowly at first, to 457 metres per second at  $10^\circ$  latitude and to 437 metres per second at  $20^\circ$ . The drop in speed then becomes rather more rapid. It is 403 metres per second at the circles of  $30^\circ$  latitude which are the extremities of the belt on either side of the equator. The equatorial belt is also distinguished by its being the recipient of the maximum amount of solar radiation at all seasons of the year.

*Secondly*, we have the belts of middle latitude comprised between the latitudes of  $30^\circ$  and  $60^\circ$  on either side of the equator. Each of these belts covers an area which is roughly one-sixth of the total area of the globe. The speed of movement is substantially less than in the equatorial belt, and also falls off steeply from 403 metres per second at  $30^\circ$  to 233 metres per second at  $60^\circ$ . The insolation of the belts of middle latitude is also notably less than that of the equatorial belt and progressively diminishes as we move polewards. It also shows large differences as between the summer and winter months.

*Thirdly*, we have the polar belts, by which term we refer to the parts comprised between the latitudes of  $60^\circ$  and  $90^\circ$ . These are of relatively small area, each being about one-fifteenth of the earth's surface. The speed of movement of the ground falls off from 233 metres per

second at  $60^\circ$  to 120 metres per second at  $75^\circ$  and becomes zero at the poles. The insolation of this belt when summed up for the whole year is much less than that of other areas on the surface of the earth. The insolation also shows large variations with the season of the year and actually vanishes during the long polar nights.

### 3. ROTATIONAL COUPLING OF EARTH AND ATMOSPHERE

A clear understanding of the manner in which the rotation of the globe influences its gaseous envelope is of the utmost importance in the present context. The forces in the nature of a frictional resistance which operate at and near the surface of contact when there is a relative motion between ground and air obviously play an important role. But this role is purely a negative one. In other words, the frictional forces act merely as a check on the relative motion, their direction being reversed when the sign of the relative motion alters. The frictional forces cannot set up or maintain a steady state of relative motion, and when such a state exists, we have to look elsewhere for an explanation of its cause or origin. It is also necessary to remark that the range of action of the frictional forces on the atmosphere is strictly limited. Some idea of this range can be obtained from observations on the manner in which the strength of a wind alters as we approach nearer the ground or move away from it. This effect is found to depend on the actual strength of the wind, on the roughness of the ground and on other factors. It may be inferred from the observations that the frictional resistance is effectively restricted to comparatively low levels in the atmosphere. A hundred metres above ground is a fair estimate of the height up to which the frictional forces dominate the behaviour

of the wind, while a kilometre may be put as the upper limit of the height beyond which their effect may be considered as negligible.

But we shall be wholly in error if we were to assume that the atmosphere at all levels above one kilometre from the ground can be regarded as a completely free medium on which the rotation of the ground below is without influence. In reality, the state of the atmosphere in its higher levels is influenced and indeed fully determined with reference to the rotation of the ground below by processes of a quasi-permanent nature which we shall now proceed to describe and discuss.

#### 4. THE VERTICAL TRANSPORT OF MOMENTUM

The atmosphere when in contact with land or water heated by solar radiation takes up both moisture and thermal energy. When the temperature of the air is thereby raised sufficiently with respect to that of the superincumbent layers, its equilibrium becomes unstable, and masses of air break off and move upwards, expanding as they go, thereby maintaining an equality of pressure with their surroundings. The expansion results in an adiabatic cooling and this suffices to check the upward movement beyond a certain height. But if the initial moisture content of the heated air is sufficient, part of it condenses out to form fine droplets of water which remain in suspension. The heat of condensation of this water is released, thereby warming the air and enabling it to mount up to still higher levels. This upward movement of heated air accompanied by the formation of clouds is a familiar phenomenon and may reach up to great heights. The important aspect of it from our present point of view is that it involves a vertical transport of momentum from the rotating earth to the upper levels of the atmosphere by a process

which is both quick and efficient. The actual momentum transported by an individual parcel of air may be small. But a great many parcels keep going up, and their total effect would evidently be cumulative when summed up over a long period of time. The final result would be to bring the air at all levels upto which these processes operate into a definite relationship with the ground below in its rotatory movement about the polar axis of the earth.

#### 5. THE ORIGIN OF THE JET-STREAM

The equatorial belt on the surface of the earth plays a highly important role in terrestrial meteorology. This is a consequence of several factors, *viz.*, the large area and central position of the belt, the high speed of its surface movement, and, above all, the fact that its insolation is more intense and much more constant through the year than that of other areas on the globe. Of particular importance in the present context is that the insolation is a maximum at the equator itself and changes but slowly within the range of ten degrees of latitude on either side of the equator. But the insolation falls off rapidly as we proceed to higher latitudes.

In the circumstance stated above, it is fully to be expected that a powerful updraft of heated air from the area in the equatorial belt comprised between the latitudes of 10° north and 10° south of the equator would be a constant feature throughout the year. The association of such heated air with water vapour would enable this updraft which carries with it the momentum of a surface-speed of 465 metres per second to reach great heights. This would also result in heavy precipitation, an inference which is strikingly confirmed on an inspection of a map showing the distribution of rainfall over the surface of the

earth. The regions of heavy rainfall with a precipitation exceeding two metres of water per annum are all found in the belt of latitudes between  $10^{\circ}$  north and  $10^{\circ}$  south of the equator. The northern parts of South America, the equatorial regions in Africa, Ceylon, Malaya, Sumatra, Java, Borneo, Celebes and New Guinea, are all regions of such heavy rainfall and lie within this range of latitudes. Indeed, outside this range, there are few areas in which there is such heavy rainfall ascribable to convectional precipitation.

It is evident that when an updraft of air from the latitude belt between  $10^{\circ}$  north and  $10^{\circ}$  south of the equator reaches the higher levels of the atmosphere, there would arise a drift of air outwards from these regions towards latitudes north and south of the equator. Two questions then arise. At what level would this outward flow commence, and how far outwards would it extend? To the first question, the answer evidently is that the outward flow would commence at the level at which the updraft has lost its driving force. The atmospheric temperature at the equator falls to the freezing point of water at a level of some five kilometres above ground. It falls further to  $-20^{\circ}\text{C.}$  at 8 kilometres, to  $-30^{\circ}\text{C.}$  at 9 kilometres and to  $-40^{\circ}\text{C.}$  at 11 kilometres. It is evident that at a height of about 10 kilometres above ground level at the equator and in all neighbouring regions, the entire content of moisture in the air would have been frozen out. The motive power for any further upward movement would then have practically disappeared. It may therefore be justifiably assumed that the horizontal drift would manifest itself principally at a height of some 10 kilometres from the ground but might extend a little both above and below

that height. It is also evident that the air thus moving north or south at high levels cannot subside or sink to lower levels in latitudes where there is even a moderate updraft of heated air. We may therefore normally expect the movement to extend over the whole of the equatorial belt, *viz.*, upto  $30^{\circ}$  of latitude or even beyond.

As the cumulative effect of the mixing with high-speed air from the equator, the air between  $0^{\circ}$  and  $30^{\circ}$  latitude at and near the 10-kilometre level would acquire a speed of approximately 465 metres per second or close to it. The difference between this speed and that of the ground below would appear as a circumpolar or zonal wind in these latitudes. The difference would be small in regions quite close to the equator. But as we proceed further north or south of the equator, the ground speed falls off rapidly, and the difference would be perceived as a circumpolar westerly wind of considerable force. If the speed of 465 metres per second is maintained upto the limits of the equatorial belt, *viz.*,  $30^{\circ}$  north or south, the circumpolar or zonal wind would have a speed in those latitudes of  $(465 - 403) = 62$  metres per second or 140 miles per hour.

#### 6. THE WESTERLY WINDS IN MIDDLE LATITUDES

When the flow of air at high levels near the equator towards the north or the south reaches latitudes where it does not meet with any updraft from below, the air-stream would subside to lower levels and at the same time become more diffuse. The belts of middle latitudes would thereby become the recipients of fast-moving air from the equatorial belt. The admixture of such air with the more slowly moving air in those latitudes would result in the atmosphere in these areas moving faster than the ground

below. As a consequence, these regions would exhibit westerly zonal winds which may be considered to be downward and poleward extensions of the high-level stream in the equatorial belt. The westerly zonal winds would extend down to ground level but their speeds would diminish in the lower levels. The winds would evidently be strongest in latitudes between 30° and 45° (north or south) and become weaker as we proceed further polewards.

#### 7. THE EASTERLY SURFACE-WINDS

The void in the atmosphere left by the streaming upwards of heated air from near the equator has, of necessity, to be filled up by air moving in towards the equator at various levels. Some of this replacement may be effected in the equatorial belt by an inflow in the marginal regions at various levels. But a substantial part of the air needed must come in at and near the ground level. Admixture of air from the higher latitudes with the atmosphere nearer the equator would reduce the speed of rotation of the atmosphere in the lower levels. Hence, at these levels, zonal easterly winds would be perceived.

#### 8. WINDS IN THE POLAR BELT

The difference between the heating effect of solar radiation in the belt of mid-latitudes and in the polar belt is sufficiently great to allow of a circuit of convection being established in these areas. Warm air goes up into the troposphere from the belt of middle latitudes. Its replacement has to be effected by colder air moving in from the polar regions. Since the surface speeds of movement are very low near the poles, the air drifting away from the poles would result in reducing the surface-speeds of the atmosphere with which it mixes. Hence, we would have a regime of easterly surface-winds in the polar belt. The warm air going up from mid-latitudes has necessarily to find its way back into the polar belts. This can be achieved by its going to the tropopause level and then drifting polewards and then slowly subsiding into the polar area. As the air thus going up is derived from the mid-latitudes where the surface speeds are much higher than in the polar belt, it follows that westerly winds with considerable speeds would be perceived as blowing over the polar areas at high levels.

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#### HERMANN VON HELMHOLTZ \*

**T**HIS is an unabridged, unaltered reprinting of the 1st (1906) edition.

This present work, prepared by a lifelong friend of Helmholtz's, is the definitive biography in English of this remarkable man. It tells of the unusual family background that directed Helmholtz's development, the philosophical background that helped form Helmholtz's method of working. It also reveals Helmholtz's personality: his mental gifts, his occasional lacunae, his buoyant hopes,

and his occasional moments of sadness. One of the great scientific biographies of all time, it reveals Helmholtz both as one of the creators of modern science and as a human being.

An unusual feature about Koenigsberger's book is that it does not stop at enumerating individual pieces of work that Helmholtz undertook. It explains each of his discoveries (as far as this is possible) in clear verbal statements that are easily followed. As you read through this book, you will understand just what Helmholtz really contributed in optics, acoustics, electrodynamics, mathematics, and the many other areas in which he worked.

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\* *Hermann von Helmholtz*. By Leo Koenigsberger. Translated by Frances A. Welby. (Dover Publications, Inc., New York), 1965. Pp. xix + 440. Price \$ 2 25.

THE TRITERPENES OF *CALOTROPIS GIGANTEA* LINN.

V. ANJANEYULU AND L. RAMACHANDRA ROW

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DURING an examination of latex-bearing plants,<sup>1</sup> Asclepiadaceae were also taken up. Of these, *Calotropis gigantea*<sup>2,3</sup> was examined some time ago in our laboratories. This investigation was started following a remark in the book "The triterpenes", Vol. III, p. 159, by Simonson and Ross that giganteol of Balakrishna, Murthy and Seshadri<sup>3</sup> could be taraxasterol. Also, the authors had suggested further investigation on isogiganteol. In view of our knowledge of other's interest on this plant, we now publish the results of our investigation, and further work on this plant has been abandoned.

The root bark was successively extracted with petroleum ether (b.p. 60–80°), ether and alcohol. Of these, ether and alcohol did not give identifiable compounds, although the former extract contained a mixture of esters (m.p. 160–70°). The petroleum ether extract was examined extensively by chromatography on alumina and fractional crystallisation. After alkaline hydrolysis of the extract, a mixture of the triterpenes were obtained which were separated through their acetates or benzoates. The following were identified:  $\alpha$ - and  $\beta$ -amyrins,<sup>4</sup> taraxasterol and its  $\eta$ -isomer<sup>5</sup> and  $\beta$ -sitosterol.<sup>6</sup>

Balakrishna, Murthy and Seshadri<sup>3</sup> recorded the separation of giganteol acetate as first fraction from the acetate mixture and the second fraction as isogiganteol acetate. It was recorded that both are monohydric alcohols analysing for  $C_{30}H_{50}O_2$ ; the function of the remaining oxygen being unknown. Following a similar procedure for the fractionation (Chart I) of the mixed acetates, (Fraction IV) using  $CHCl_3$ -MeOH, the first fraction corresponded closely with giganteol acetate (T.L.C. single spot) of Balakrishna, Murthy and Seshadri,<sup>3</sup> it was identical (m.p. and I.R.) with an authentic sample of taraxasteryl acetate. The second fraction (Fraction VI) showed similar correspondence with that of isogiganteol acetate, but exhibited three prominent spots on T.L.C. Separation of this fraction by further crystallisation from  $CHCl_3$ -MeOH was not fruitful. It was hydrolysed and fractionated further with  $CHCl_3$ -MeOH whereby  $\alpha$ -amyrin (m.p. 184–86°) could be isolated. The sparingly soluble fraction

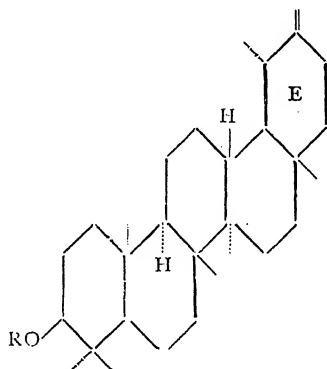
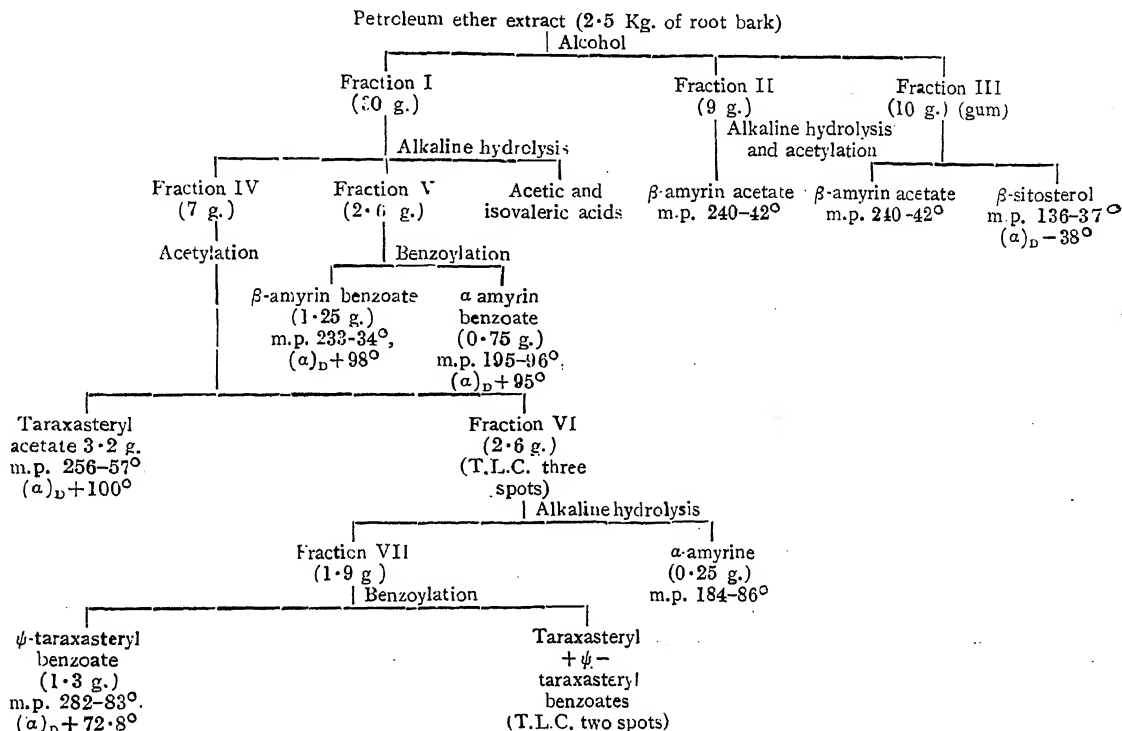
(Fraction VII) was benzoylated and fractionated to give  $\eta$ -taraxasteryl benzoate, (m.p. 282–83°). The tail fraction contained a mixture of taraxasteryl and  $\eta$ -taraxasteryl benzoates (T.L.C., two spots) identified by co-chromatography on T.L.C. In the experiments recorded above, no fraction could be isolated which gave basic analysis of  $C_{30}H_{50}O_2$  for alcohols. It was, therefore, presumed that the analysis of Balakrishna, Murthy and Seshadri<sup>3</sup> might be for the hydrates and it is not unknown that taraxasterol crystallised with the solvent of crystallisation.<sup>7</sup>

In the hydrolysate of Fraction I (Chart I), acetic acid and isovaleric acid were identified leading to the conclusion that some of the above triterpenes, if not all, might be in the form of their esters. So, unhydrolysed esters were fractionated from alcohol and each fraction chromatographed on alumina column eluting with petroleum ether (b.p. 40–60°), petroleum ether-benzene (1:1) and benzene. After several complicated fractionations,  $\beta$ -amyrin acetate, m.p. 240–42°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 96° and taraxasteryl isovalerate, m.p. 228–29°, were separated from petroleum ether eluate and taraxasteryl acetate, m.p. 254–55°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 98° from benzene eluate. Three unidentified ester fractions from petroleum ether eluate, m.p. 207–209°, m.p. 195–206° and m.p. 130–40° were not studied any further.

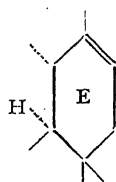
Similar careful extensive fractionation of the petroleum ether extract of the leaves gave rise to  $\beta$ -amyrin, taraxasterol and its  $\eta$ -isomer after alkaline hydrolysis. Attempts were made to isolate the esters of these triterpenes. There was good evidence of isovalerate of taraxasterol (m.p. 226–28°); but no attempts were made to confirm.

During the course of identification of taraxasterol (I) through transformation to known compounds, action of protonic reagents was studied. Taraxasterol (I) was reported to be isomerised in presence of 90% formic acid to  $\eta$ -taraxasteryl formate (II)<sup>5</sup> and with acetic acid- $H_2SO_4$  to lupenol-I (III).<sup>8</sup> During our study, it was noticed that  $CHCl_3$ -HCl readily converts taraxasteryl acetate (IV) to  $\eta$ -taraxasteryl acetate (V). The strength of formic acid appears to be crucial, for 80% formic acid in benzene would give the formate

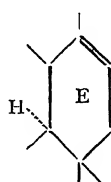
CHART I



I, R=H  
IV, R=AC  
VI, R=Formyl



II, R=Formyl  
V, R=AC



III, R=H  
VII, R=AC

ester of taraxasterol (VI) with no isomerisation and similarly HOAc-HCl is a poorer reagent even at 100° than HOAc-H<sub>2</sub>SO<sub>4</sub> at room temperature as it yields a mixture of  $\eta$ -taraxasteryl acetate and lupenyl-I acetate (VII).

All compounds analysed satisfactorily and they were identified through their derivatives, I.R. spectra and by comparison with authentic samples (M.M.P. and I.R.).

Our thanks are due to the University Grants Commission, New Delhi, for a Junior Fellowship to one of us (V.A.).

1. Anjaneyulu, V. and Ramachandra Row, L., *Curr. Sci.*, 1967, **36**, 204.
2. Hill, E. G. and Sirkar, A. P., *J. Chem. Soc.*, 1915, p. 1437.
3. Balakrishna, K. J., Murthy, P. B. R. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1943, **22 A**, 138.
4. Ramachandra Row, L., Prakasa Sastry, C. S. and Suryanarayana Murthy, P., *Curr. Sci.*, 1966, **35**, 146.
5. Athrinios, A. E., El-Kholly, I. E. and Solmon, G., *J. Chem. Soc.*, 1962, p. 1700.
6. Sankara Rao, C., Sundhara Ramaiah, T. and Ramachandra Row, L., *Curr. Sci.*, 1966, **35**, 457.
7. Haines, D. H. and Warren, F. L., *J. Chem. Soc.*, 1949, p. 2556.
8. Ames, T. R., Beton, J. L., Bowers, A., Halsall, T. G. and Jones, E. R. H., *Ibid.*, 1954, p. 1905.

## FOSSIL PALM REMAINS FROM BOMMURU, ANDHRA PRADESH

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**B**OMMURU is a small village about 3.5 miles S.E. of Rajahmundry in Andhra Pradesh. It is surrounded by low plateau hills sedimentary in origin, made up of soapy clays and shales of current bedding with white, yellow, and pinkish layers. They form the Upper Series of Rajahmundry sandstones King,<sup>1</sup> 1880, p. 250). They lie uncomfortably over the Deccan Traps in this area. They have a low dip, 8-10° towards South (Krishnan *et al.*,<sup>2</sup> 1962, p. 662). They are equivalent of Cuddalore Series in South Arcot District of the Madras State (King,<sup>1</sup> 1880, p. 152; Pascoe,<sup>3</sup> 1963, p. 1879; Krishnan *et al.*,<sup>2</sup> 1962, p. 65).

On the basis of their deposition over the Deccan Traps, the age of these formations is given as Middle Eocene (King,<sup>1</sup> 1880, p. 252), or Miocene-Pliocene (Krishnan,<sup>4</sup> 1956, p. 513), or Oligocene-Miocene (Mahabale,<sup>5</sup> 1966, p. 23). But no animal or plant fossils from this area at Bommuru were described in support of these views.

Several impressions of palm and other remains were collected by us at Bommuru on pink, yellow and white current bedding shales, the more important of which are described below:

1. *Specimen No. B. 47/63*.—This has the impressions of two leaflets of a pinnate palm on a light pink shale. One of them is preserved in parts. It is 9 × 3 cm. and shows clearly even minute details of venation (Fig. 1). It has a moderately thick midrib, 1-1.5 mm. with 9-11 other veins of the first order parallel to it on either side. They are less conspicuous than the midrib. The veins of the second order arise laterally from them at right angles and are wavy. The veins of the second order give rise to smaller veins of the third order and are inter-connected. They are very thin and are more or less parallel to the long veins of the first order. Comparing this venation pattern in the leaflets on the specimen, it seems to resemble very closely with the venation in the leaflets of the pinnæ in *Cocos nucifera* L. (Fig. 2).

2. *Specimen No. B. 61/63*.—This has impressions of two leaflets of another palm leaf on a pink shale, preserved in part. They are 18 × 4.5 cm. respectively (Fig. 3). There is a thick midrib, 4 mm. The margin is entire and smooth. Venation is parallel, though rather faint. There are 11-13 such veins parallel to midrib. Some of the parallel veins are thicker than others. This specimen differs from the previous one in this character. The parallel veins of the first order in specimen No. B. 47/63 are thick uniformly, but in this specimen they are not of uniform thickness.

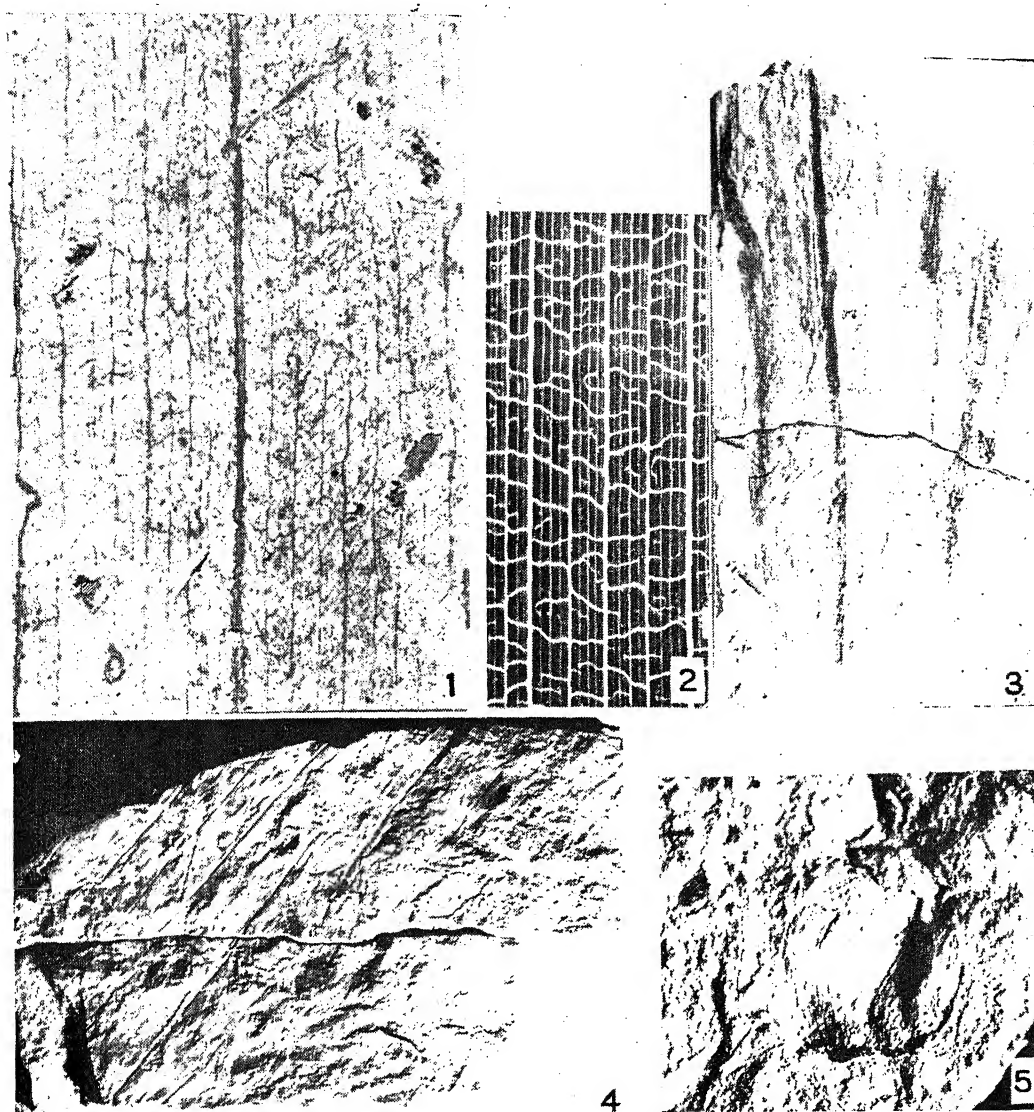
3. *Specimen No. B. 73/63*—shows a part of Impression of a leaf on pale yellow shale. It is 16 × 17 cm. and consists of fan-shaped part of a palm leaf probably above hastula in a palmate-leaved palm (Fig. 4). The individual leaflets are 6 in number, 2-3.5 cm. broad, each with a midrib 1 mm. thick. Other details are not well preserved.

4. *Specimen No. B. 60/63*.—This is an impression of a small palm-fruit on a white shale (Fig. 5). It is 1.5 × 1.3 cm., oval in shape with concave attachment at the base, and has a broadly rounded tip. The fibres of the mesocarp are seen in the impression to pass from base to the apex of the fruit. In shape and size, this palm fruit resembles the fruits of a small-fruited species of *Cocos*, like *C. plumosa*, *C. coronata* and others. Presumably it belongs to some such members of that genus or a related palm having small fruits, but not to the large-fruited one as *C. nucifera*.

Some dicot leaf impressions were also collected which are under study.

These fossil palm remains in this area are rather unique and support the view of Mahabale<sup>5</sup> (1966, p. 21) that different species of palmate and pinnate palms enjoyed a wide range of climate and distribution in the Tertiary period in India, as also elsewhere. They also provide palaeobotanical evidence for the age of these formations, viz., Rajahmundry sandstones at Bommuru as late Tertiary, since the Rajahmundry Traps below are generally believed to be of the early Tertiary period, probably Eocene (Pascoe,<sup>3</sup> 1963, p. 1383; Sahni,<sup>6</sup> 1940, p. 21; Rao, L. R. *et al.*,<sup>7</sup> 1936, p. 161).





FIGS. 1-5. Fossil palm remains at Bommuru. Fig. 1. A part of a fossil palm leaf impression No. B. 47/63  $\times 2$ . Fig. 2. Venation in a pinna of *Cocos nucifera* leaflet,  $\times 2$ . Fig. 3. Two fossil palm leaf impressions No. B. 61/63,  $\times \frac{1}{2}$ . Fig. 4. Impression of a part of palmate palm leaf No. B. 73/63,  $\times \frac{1}{2}$ . Fig. 5. Impression of a fossil palm fruit No. 60/63, almost natural size.

- King, W., "Coastal region of the Godavari District," *Mem. Geo. Surv. Ind.*, 1880, 16 (3), 231.
- Krishnan, M. S., Rao, V. B., Rao, P. S. and Brahmam, N. K., "Magnetic Survey of Godavari Valley," *Bull. Nat. Inst. Sci. India*, 1962, 22, 64.
- Pascoe, H. E., *A Manual of the Geology of India and Burma*, 1963, II Ed. 3, 1345.
- Krishnan, M. S., *Geology of India and Burma*, III Ed., 1956, p. 501, Madras.
- Mahabale, T. S., "Flora of the Deccan: Past and present," *Pres. Add. (Botany Section) 53rd Indian Sci. Congr.*, Chandigarh, 1966, p. 1.
- Sahni, B., "The deccan traps: An Episode of the Tertiary Era," *Gen. Pres. Add., Proc. 27th Indian Sci. Congr.*, 1940, 2, 1.
- Rao, L. R., Rao, S. R. N. and Rao, K. S., "The age of the Deccan traps near Rajahmundry," *Proc. Ind. Acad. Sci.*, 1936, 3 B (2), 157.

## LETTERS TO THE EDITOR

THE FIRST IONIZATION POTENTIAL  
OF OXYGEN MOLECULE

IN a forthcoming communication from this laboratory, it is shown that the  $v''$  numbering of the 2nd negative band system ( $A^2\Pi_u \rightarrow X^2\Pi_g$  transition) of  $O_2^+$  has to be increased by one unit. This is proved by the isotope shifts, due to species  $^{16}O_2^+$ ,  $(^{16}O^{18}O)^+$  and  $^{18}O_2^+$ , of the numerous bands of this extended system.

The discovery has an important bearing on the first ionization potential (IP) of  $O_2$  for which Samson and Cairns<sup>1</sup> have recently proposed the value  $12.063 \pm 0.001$  eV. This value is based on the assumption that the step in the photo-ionization cross-section curve at  $1009 \pm 0.5$  Å which is identified in the absorption spectrum at  $1008.7 \pm 0.1$  Å refers to  $O_2^+$  in its  $v = 1$  level of the  $X^2\Pi_g$  state. Hence the energy difference between the levels  $v = 1$  and 0, as known earlier,<sup>2</sup> viz.,  $1843.34 \pm 2.0$  cm.<sup>-1</sup> is deducted from the value corresponding to  $1008.7 \pm 0.01$  Å to obtain the above value of IP. This will need revision, because of the present discovery, in one of the following two ways.

(a) If the photo-ionization at  $1008.7$  Å refers to the real  $v = v$  level of  $X^2\Pi_g$  state, as is very likely, and not to the old  $v = 1$  level (which now becomes  $v = 2$ ) the IP will have to be deduced by using the new value of  $1876.40$  cm.<sup>-1</sup> which is the correct difference between the real  $v = 1$  and 0 levels. In this case the corrected IP according to Samson and Cairns will be  $12.059 \pm 0.001$  eV.

(b) If on the other hand, as is not very likely, it refers to the old  $v = 1$  level which is the real  $v = 2$  level, the IP will have to be obtained by using  $3719.74$  cm.<sup>-1</sup> which is the difference between the levels  $v = 2$  and 0 of the  $X^2\Pi_g$  state. In this case the corrected IP will be  $11.830 \pm 0.001$  eV.

However, the photo-ionization cross-section curves of Samson and Cairns and the fact that they saw no signs of ions in the low pressure cell beyond  $1028.6 \pm 0.8$  Å ( $12.05 \pm 0.01$  eV), strongly favour the former value, viz.,  $12.059 \pm 0.001$  eV.

The convergence limit of the 2nd negative bands of  $O_2^+$  in emission extending into the vacuum u-v region provides another direct

spectroscopic method of arriving at the IP of  $O_2$ . This point is now being investigated.

Spectroscopy Division, R. K. ASUNDI.  
BARC, Trombay, Bombay,  
February 27, 1968.

1. Samson, J. A. R. and Cairns, R. B., *J. Opt. Soc.*, 1966, **56**, 769.
2. Herzberg, G., *Spectra of Diatomic Molecules*, 1950, p. 500.

EMISSION SPECTRUM OF  
META-FLUOROPHENOL

THE emission spectrum of *meta*-fluorophenol in the near ultraviolet has been excited by transformer discharge through its flowing vapour. The flow was so adjusted that the discharge always remained of greenish colour throughout the entire length of the discharge tube. A voltage of about 3 kV was required to excite the spectrum. However, a higher potential was needed to initiate the discharge. An exposure of 3 hours was sufficient to photograph the spectrum on Hilger medium quartz spectrograph with a slit width of  $30 \mu$  on Ilford N-30 plates. The accuracy of the measurement is believed to be  $\pm 5$  cm.<sup>-1</sup> for strong and sharp bands and  $\pm 10$  cm.<sup>-1</sup> for weak bands.

As regards the earlier spectral studies of *m*-fluorophenol, the infrared and electronic absorption spectra have been studied by Tiwari.<sup>1,2</sup> Kohlrausch *et al.*<sup>3</sup> have given the theoretically interpolated Raman lines and have also indicated the nature of polarisation of the lines.

The transition responsible for this emission band system is the electronically forbidden transition  $A_{1g} \leftarrow B_{2u}$  of benzene. Under the reduced symmetry  $C_s$ , to which *m*-fluorophenol belongs, the above transition transforms to an allowed transition  $A' \leftarrow A'$ , the transition moment lying in the plane of the molecule. Hence, 30 benzene-like vibrations will consist of 21 totally symmetric group with species ( $a'$ ) and 9 non-totally symmetric group with species ( $a''$ ). The vibrations of both the species are allowed in all the spectra. Vibrations with species ( $a'$ ) should give polarised and ( $a''$ ) depolarised Raman lines.

The emission bands, which are red degraded and sharp in general, extend from 2730 Å to

TABLE I

A correlation of the ground state fundamentals (emission) of meta-fluorophenol molecule with absorption (I.R. + U.V.) and Raman values (All the values are in  $\text{cm}^{-1}$ )

Infrared		Raman interpolated	Ultraviolet		Mode of vibrations
Liquid	Vapour		Absorption	Emission	
535 (s)	..	340 (mp)	..	339 (m)	$a'$ } Components of $e_g^+$ (606)
740 (s)	..	530 (sp)	527	533 (s)	$a'$ }
845 (vs)	842 (vw)	740 (sp)	742	743 (s)	$a'$ } Ring breathing
1005 (s)	..	..	..	860 (ms)	..
1290 (vs)	1300 (w)	1000 (vsp)	..	1007 (s)	$a'$ } C—C—C Triagonal bending
1512 (vs)	1512 (ms)	1285 (sp)	..	1272 (s)	$a'$ } C—F Stretching
		..	..	1535 (s)	$a'$ } C—C Stretching

The letters in parentheses indicate the nature of polarisation and visual estimate of the intensity: p—polarised, v—very, s—strong, m—medium and w—weak.

2980 Å. It has been possible to measure 60 of them. Some of the strong bands appear as double-headed. The 0,0 band of the system has been taken at  $36620\text{ cm}^{-1}$  from the absorption spectrum<sup>1</sup> of the molecule. The location of the 0,0 band in the emission spectrum is not very clear because of self-absorption. The bands at wavenumber separations of 339, 533, 743, 860, 1007, 1272 and  $1535\text{ cm}^{-1}$  from the 0,0 band have been analysed as the ground state fundamental vibrational frequencies. These frequencies appear with sufficient intensity and combine with each other. Most of these are excited up to more than one quantum. A correlation of these fundamentals with those of Raman, infrared and electronic absorption spectra has been presented in Table I. The agreement is quite satisfactory. Most of the fundamentals have, also, been assigned to definite modes on the basis of comparison with the available data on similar molecules.

The authors are indebted to Prof. D. Sharma for his keen interest and valuable guidance throughout this investigation. They are also thankful to CSIR, New Delhi, for granting Fellowship to one of them (B. J. A.).

Department of Physics, B. J. ANSARI.  
University of Gorakhpur, S. L. SRIVASTAVA.  
Gorakhpur, U.P. (India),  
December 5, 1967.

1. Tiwari, S. K., *Nature*, 1963, 200, 1202.
2. —, *Research Report*, Department of Spectroscopy, B.H.U., Benares, 1961-66.
3. Hertz, E., Kohlrausch F. and Vogel, R., *Monatsch*, 1947, 76, 249.

### ROTATIONAL ANALYSIS OF THE VISIBLE A-X SYSTEM OF BiBr MOLECULE

THE band spectrum of BiBr in the visible region was investigated in emission by Howell and Rochester<sup>1</sup> (1934) and Narayanan, Patel and Narayanan<sup>2</sup> (1962) and in absorption by Morgan<sup>3</sup> (1936). The spectrum was known to consist of two systems of bands, one in the region  $\lambda\lambda$  4595–6063 Å, designated as A-X and the other in the region  $\lambda\lambda$  3862–5129 Å, designated as B-X. The common lower state "X" of both the systems is known to be the ground state of the BiBr molecule. The red degraded A-X system appears to be the analogue of the well-known visible A-X<sub>1</sub> system of BiF, (recently designated as A<sub>2</sub>-X<sub>1</sub> system by Patel and Narayanan<sup>4</sup>) for which a detailed rotational analysis has been reported by Rao and Rao<sup>5</sup> (1962), and Mohanty and Upadhyay<sup>6</sup> (1967). From the results of their analysis, they concluded that the transition of the A-X<sub>1</sub> system is a  $O^+-O^+$  which is the case (c) equivalent of  $^3\Sigma^+ - ^3\Sigma^-$ . The X<sub>1</sub> level was attributed by them to the  $^3\Sigma^-(O^+)$  state of the ground state electron configuration

$$(z\sigma)^2(y\sigma)^2(x\sigma)^2(w\pi)^4(v\pi)^2 \dots \dots \dots ^3\Sigma^-$$

The first excited level was attributed to the  $^3\Sigma^-(O^+)$  state of the first excited electron configuration

$$(z\sigma)^2(y\sigma)^2(x\sigma)^2(w\pi)^3(v\pi)^3 \dots \dots \dots ^3\Sigma^-$$

The fine structure of the (7,0), (7,4) and (1,4) bands of the A-X system of BiBr has been studied in the first order of a 21 ft. concave grating spectrograph (dispersion  $1.25\text{ Å/mm.}$ ) with the object of determining the rotational constants of the upper and the

lower states and the nature of the electronic transition. Each band reveals a simple structure consisting of single P and R branches and thus the system seems to involve a transition in which,  $\Delta Q = 0$ , if Hund's case (c) applies for both the states as in the corresponding A-X<sub>1</sub> system of BiF. From a detailed rotational analysis of the three bands, rotational constants of the upper and lower states are determined and are given in Table I.

TABLE I  
Rotational constants of various levels of the  
A-X system of BiBr<sup>79</sup>

Band assignment	Band origin in cm <sup>-1</sup>	B <sub>v</sub> ' in cm <sup>-1</sup>	B <sub>v</sub> '' in cm <sup>-1</sup>
1,4	19801.2	0.036 <sub>s</sub>	0.044 <sub>s</sub>
7,4	20540.9	0.034 <sub>s</sub>	0.044 <sub>s</sub>
7,0	21366.5	0.034 <sub>s</sub>	0.045 <sub>0</sub>

Spectroscopy Lab., P. SREENIVASA MURTY.  
Dept. of Physics, P. TIRUVENGANNA RAO.  
Andhra University,  
Waltair, January 18, 1968.

1. Howell, H. G. and Rochester, G. D., *Univ. Durham. Phil. Soc. Proc.*, 1934, 9, 126.
2. Sankaranarayanan, S., Patel, M. M. and Narayanan, P. S., *Proc. Ind. Acad. Sci.*, 1962, 56, 171.
3. Morgan, F., *P.R.*, 1936, 49, 41.
4. Patel, M. M. and Narayanan, P. S., *Ind. J. Pure and Appl. Phys.*, 1967, 5, 191.
5. Rao, T. A. P. and Rao, P. T., *Can. J. Phys.*, 1962, 40, 1077.
6. Mohanty, B. S. and Upadhyaya, K. N., *Curr. Sci.*, 1967, 36, 478.

### SOME EVIDENCE REGARDING THE IONIC NATURE OF MAGNESIUM FLUORIDE

**Introduction.**—Magnesium fluoride (MgF<sub>2</sub>) has a tetragonal structure isomorphous with rutile. The material is now available in the form of large single crystals and has several useful properties. It has a high melting point, it is quite hard, it is almost insoluble in water and gives a prominent Raman effect—properties which suggest that the interatomic binding is probably covalent. Krishnan and Katiyar<sup>1</sup> state that this compound has considerable molecular character. In a recent lattice dynamical study the same authors<sup>2</sup> opine that the compound has a partially ionic character. However, Bauer<sup>3</sup> and Brackett and Brackett<sup>4</sup> treat the binding as completely ionic. They have applied the theory of ionic crystals to calculate the cohesive energy. There is good agreement between the theoretical and experi-

mental values of the cohesive energy, which indicates that the binding is essentially ionic. The purpose of this communication is to present some calculations which are believed to furnish additional evidence regarding the ionic nature of the binding in this compound. These are (i) the calculation of the compressibility, from the classical theory of ionic crystals, (ii) the calculation of the coefficient of thermal expansion from the classical theory of ionic crystals, (iii) the calculation of the Gruneisen parameter from crystal properties and (iv) the calculation of the effective charge of the ions.

**Compressibility.**—The compressibility can be calculated from the cohesive energy. Calculations of the cohesive energy of MgF<sub>2</sub> have been made by Bauer<sup>3</sup> and Brackett and Brackett.<sup>4</sup> Bauer<sup>3</sup> has calculated the Coulomb interaction energy and the repulsion energy using an inverse power term. The calculations made by Brackett and Brackett<sup>4</sup> may be considered more realistic in the sense that they have used an exponential term for the repulsion energy and have also included the contribution of the Van der Waals interaction. The form of the potential energy function used by Brackett and Brackett<sup>4</sup> is:

$$U = N [-(4Ae^2/r) + (Bc''') - (C/r^6)]$$

where the three terms respectively represent the Coulomb energy, the repulsion energy and the Van der Waals interaction energy. The constant  $g$  is chosen to be equal to 2.31. No bulk property has been used in the calculation of the various terms.

If  $U$  is the cohesive energy of a crystal, its compressibility is given by<sup>5</sup>:

$$(1/\gamma) = (1/9Ncr)(d^2U/dr^2)$$

Applying this method to the cohesive energy given by Brackett and Brackett,<sup>4</sup> we obtain for  $\gamma$  the value  $9.6 \times 10^{-13}$  cm.<sup>2</sup>/dync. An experimental value of  $\gamma$  could not be traced in literature. Apparently, the compressibility of MgF<sub>2</sub> has not yet been measured. This is surprising in view of the availability of large single crystals. However, it is possible to make fairly reasonable estimates of  $\gamma$  by several other methods. In Table I the values of  $\gamma$  estimated from other data are given. It is seen that the value of  $\gamma$  estimated from the theory of ionic crystals lies within the range of values obtained from other methods.

**Thermal Expansion.**—Smythe<sup>13</sup> has developed a method of calculating the thermal expansion of a solid from its cohesive energy and specific

heat. This method has been employed by Mitra and Joshi<sup>14</sup> and Sirdeshmukh<sup>15-17</sup> to calculate the thermal expansion of a variety of crystals. The working equation which is obtained by this method may be represented by:

$$\alpha = - (C_p/2r) (d^3U/dr^3)/(d^2U/dr^2)^2$$

where  $\alpha$  is the coefficient of thermal expansion and  $C_p$  is the molar specific heat.  $C_p$  for  $MgF_2$  at room temperature is 13.7 cal./gm. mole.<sup>18</sup> Applying the above method to the cohesive energy function given by Brackett and Brackett<sup>4</sup> the value  $14.0 \times 10^{-6} \text{ C}^{-1}$  is obtained for the average linear expansion coefficient of  $MgF_2$  at room temperature. This is to be compared with the value  $10.7 \times 10^{-6} \text{ C}^{-1}$  obtained by Rao *et al.*<sup>19</sup> by the X-ray method. It may be mentioned here that Brackett and Brackett<sup>4</sup> have arbitrarily chosen the value 2.31 for  $g$  in the term representing the repulsion energy. A more proper evaluation of the potential parameters is necessary. This could be done when reliable values of the elastic constants become available. In the meantime, the present degree of agreement between the calculated and experimental values of the expansion coefficient may be considered reasonably good.

**The Gruneisen Parameter.**—The Gruneisen parameter ( $\gamma$ ) can be calculated from the thermal and elastic properties using the relation<sup>20</sup>:

$$\gamma = (3\alpha V)/(\psi C_p)$$

where  $\alpha$  is the coefficient of linear expansion,  $V$  the molar volume,  $\psi$  the compressibility and  $C_p$  the molar specific heat. The room temperature values of  $\alpha$  and the specific heat are given in Sec. III. Since a unique value of  $\psi$  is not available  $\gamma$  was calculated with the various values of  $\psi$  given in Table I. These values of  $\gamma$  are given in Table I, column 3. The value 3.2 is rather too large. Anyhow,  $\gamma$  for  $MgF_2$  seems to be of the order of 2.5. For ionic crystals like the alkali halides  $\gamma$  lies in the range 1-2.<sup>21</sup> For crystals with a covalent character  $\gamma$  is generally less than 1 at room temperature.<sup>22</sup> Srinivasan<sup>23,24</sup> opines that a value of  $\gamma$  less than 1 is suggestive of some covalent contribution. The Gruneisen parameter of  $MgF_2$  is thus of the order to be expected for a predominantly ionic crystal.

**The Effective Ionic Charge.**—Another parameter which is useful in assessing the ionicity is the effective ionic charge  $q = e^*/e$  introduced by Szigeti<sup>25</sup> in his theory of dielectrics.

Szigeti has calculated the effective ionic charge for  $TiO_2$  but he had some difficulty in interpreting the reflectivity data. However, since we are interested in an estimate of the average value of  $q$ , we have followed the procedure adopted by Moss.<sup>26</sup> Moss combined the two Szigeti relations,<sup>25,27</sup> one for  $q$  and the other for  $\psi$ . This procedure gives in the present case:

$$q = (27v/16\pi e^2 r^2)^{1/2} [(\epsilon_0 - \epsilon_\infty)/(\epsilon_0 + 2)]^{1/2} (1/\psi)^{1/2}$$

Here  $v$  is the molecular volume,  $\psi$  is the compressibility,  $r$  is the interionic distance, and  $\epsilon_0$  and  $\epsilon_\infty$  are the static and high frequency dielectric constants. The number 16 appears in the denominator since the formal valence of Mg is 2. The values of the dielectric constants are taken from Barker's<sup>28</sup> data. The average values are taken.  $q$  was evaluated using the various values of  $\psi$  given in Table I, column 2.

TABLE I

Estimates of the compressibility, gruneisen parameter and effective ionic charge for  $MgF_2$

Method of estimating compressibility ( $\psi$ )	$\psi \times 10^{13}$ cm. <sup>2</sup> dyne	$\gamma$	$q$
1. From the compressibility <sup>6</sup> of $TiO_2$ and the hardness <sup>7</sup> of $MgF_2$ and $TiO_2$ using the relation <sup>8</sup> between hardness and compressibility	8.3	2.7	0.93
2. From the compressibility <sup>6</sup> of $TiO_2$ and the thermal expansion <sup>9</sup> of $TiO_2$ and $MgF_2$ using the relation <sup>10</sup> between the compressibility and thermal expansion	6.9	3.2	1.02
3. From the volume of $MgF_2$ and its 'atomic number' using Knopoff's <sup>11</sup> method	8.5	2.6	0.92
4. From the young's modulus of polycrystalline $MgF_2$ <sup>12</sup> and an assumed value of Piosson's ratio $\sigma=0.3$ using the relation $\psi=3(1-2\sigma)/V$	10.4	2.1	0.83

These values of  $q$  are given in Table I, column 4. The effective charge of the fluorine ion turns out to be in the range 0.83e-1.02e and that of the Mg ion turns out to be in the range 1.66e-2.04e. Recently Krishnan and Katiyar<sup>2</sup> have used ionic charges 0.7e and 1.4e for the fluorine and magnesium ions respectively in their lattice dynamical work on  $MgF_2$ . These values agree closely with the lower limits of the values obtained in this work. It is interesting to compare the value of  $q$  for  $MgF_2$  with the  $q$ -values of some typical ionic and covalent crystals. The value of  $q$  is of

the order of 0.7–1 for ionic crystals like the alkali halides.<sup>25</sup> On the other hand for covalent crystals like SiC, ZnO, ZnS, etc., the value of  $q$  is much lower; it is of the order of 0.2–0.5.<sup>29</sup> We thus see that the effective charge of the ions in  $\text{MgF}_2$  is of the order to be expected for a highly ionic crystal.

**Conclusion.**—The compressibility and thermal expansion of  $\text{MgF}_2$  have been calculated from the classical theory of ionic crystals and the calculated values are compared with experimental data. The Gruneisen parameter has been calculated from the experimental data on the thermal expansion and it turns out to be of the order expected for ionic crystals. The dielectric constant data have been used to calculate the effective charge of the ions using Szigeti's theory. All these approaches lead to the conclusion that the interatomic binding in  $\text{MgF}_2$  crystal has a high degree of ionicity.

**Acknowledgement.**—The author thanks the referee for some useful suggestions and for drawing his attention to the recent work by Krishnan and Katiyar.

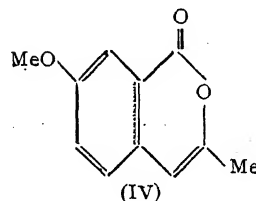
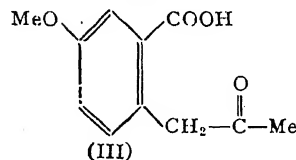
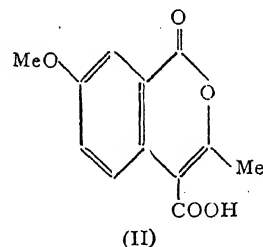
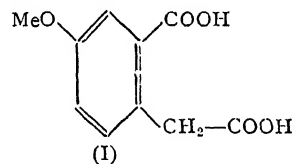
Physics Department, D. B. SIRDESHMUKH.  
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Hyderabad-7, November 3, 1967.

1. Krishnan, R. S. and Katiyar, R. S., *J. Phys. (France)*, 1965, **26**, 627.
2. — and —, *Ind. J. Pure and Appl. Phys.*, 1967, **5**, 237.
3. Bauer, W. H., *Acta Cryst.*, 1961, **14**, 209.
4. Brackett, T. E. and Brackett, E. B., *J. Phys. Chem.*, 1965, **69**, 3611.
5. Kittel C., *Introduction to Solid State Physics*, Asia Publishing House, Bombay, 1964.
6. *Int. Critical Tables*, McGraw Hill Book Co., Inc., New York, 1926, **3**, 50.
7. Plendl, J. N. and Gielisse, P. J., *Phys. Rev.*, 1962, **125**, 828.
8. Pretzel, F. E., Rupert, G. N., Mader, C. L., Storms, C. K., Gritton, G. V. and Rusbing, C. C., *J. Phys. and Chem. of Solids*, 1960, **16**, 10.
9. Rao, K. V. K. and Naidu, S. V. N., *J. Osmania Univ.*, 1963, **1**, 34.
10. Sirdeshmukh, D. B., *J. Appl. Phys.*, 1967, **38**, 4083.
11. Knopoff, L., *Phys. Rev.*, 1965, **138**, 1445.
12. Ballard, S. S. and Browder, J. S., *Appl. Optics*, 1966, **5**, 1873.
13. Smythe, H. T., *J. Am. Ceram. Soc.*, 1955, **38**, 140.
14. Mitra, S. S. and Joshi, S. K., *J. Chem. Phys.*, 1961, **31**, 1462.
15. Sirdeshmukh, D. B., *J. Appl. Phys.*, 1960 **37**, 3910.
16. —, *Ind. J. Pure and Appl. Phys.*, 1966, **4**, 323.
17. —, *Curr. Sci.*, 1967, **36**, 372.
18. *Gmelins Handbuch der Anorg Chemie.*, 1937, p. 100.
19. Rao, K. V. K., Naidu, S. V. N. and Setty, P. L. N., *Acta Cryst.*, 1962, **15**, 528.
20. Brackett, T. E. and Brackett, E. B., *J. Phys. Chem.*, 1965, **69**, 3611.
21. Born, M. and Huang, K., *Dynamical Theory of Crystal Lattices*, Acad. Press, New York, 1954,

22. Sirdeshmukh, D. B., *J. Appl. Phys.*, (In press).
23. Srinivasan, R., *Proc. Ind. Acad. Sci.*, 1955, **41 A**, 49.
24. —, *Ibid.*, 1955 **42 A**, 91.
25. Szigeti, B., *Trans. Faraday Soc.*, 1949, **45**, 155.
26. Moss, T. S., *Proc. Phys. Soc.*, 1959, **74**, 490.
27. Szigeti, B., *Proc. Roy. Soc.*, 1950, **204**, 51.
28. Barker, A. S., *Phys. Rev.*, 1964, **136 A**, 1290.
29. Anderson, O. L. and Glynn, P., *J. Phys. and Chem. of Solids*, 1965, **26**, 191C.

## ISOCOUMARINS : SYNTHESIS OF 7-METHOXY-3-METHYLISOCOUMARIN

7-Methoxy-3-methylisocoumarin has been synthesised in good yield from 4-methoxyhomophthalic acid<sup>1a</sup> in three simple stages thus providing a new simple general method for the synthesis of 3-methylisocoumarin derivatives from the corresponding homophthalic acids. The 3-methylisocoumarin derivatives have been isolated recently from micro-organisms, viz., 8-hydroxy-3-methylisocoumarin from the fungus *Marasmius ramealis*<sup>2</sup> and Reticulol (7-methoxy-6, 8-dihydroxy-3-methylisocoumarin) from *Streptomyces rubroreticuli*.<sup>3</sup> The earlier reported methods<sup>4,5</sup> for the synthesis of 3-methylisocoumarin derivatives involve a number of steps.



4-Methoxyhomophthalic acid<sup>1a</sup> (I) on condensation with acetic anhydride in presence of pyridine or fused sodium acetate on boiling water-bath for two hours, furnished 4-carboxy-7-methoxy-3-methylisocoumarin. (II) [Needles from ethyl acetate, m.p. 210–211°. Found: C, 61.3, H, 4.7; C<sub>12</sub>H<sub>10</sub>O<sub>5</sub> requires, C, 61.5; H, 4.3]. It gave U.V. absorption characteristic of the isocoumarins,<sup>1b</sup>  $\lambda_{(\text{MeOH})}^{\text{max.}}$ : 230, 270, 348 m $\mu$ ; log  $\epsilon$ , 4.46, 4.06, 3.71. The isocoumarin (II) on refluxing with aq. NaOH for one and half hours and then acidifying with HCl furnished 2-carboxy-4-methoxybenzyl methyl ketone (III) [Needles from water, m.p. 133–34°, Found: C, 63.2, H, 5.9; C<sub>11</sub>H<sub>12</sub>O<sub>4</sub> requires, C, 63.4, H, 5.7]. The ketone (III) cyclodehydrated on keeping with sulphuric acid overnight at room temperature to give 7-methoxy-3-methylisocoumarin (IV) [Needles from petrol ether (60–80°), m.p. 93–94°. Found: C, 69.5, H, 5.6; C<sub>11</sub>H<sub>10</sub>O<sub>3</sub> requires, C, 69.4, H, 5.2]. U.V. absorption,  $\lambda_{(\text{MeOH})}^{\text{max.}}$  230, 269, 348 m $\mu$ ; log  $\epsilon$ , 4.53, 4.03, 3.60.

Condensation of 4-methoxyhomophthalic acid with propionic anhydride in the presence of pyridine takes place in similar way to give 7-methoxy-3-ethylisocoumarin by the same sequence of the reactions [Needles from petrol ether (40–60°), m.p. 45–46°. Found: C, 70.4, H, 5.8; C<sub>12</sub>H<sub>12</sub>O<sub>3</sub> requires, C, 70.5, H, 5.8]. It shows U.V. absorption in MeOH with  $\lambda_{\text{max.}}$  229, 269, 348 m $\mu$ ; log  $\epsilon$ , 4.54, 4.04, 3.62.

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Bombay-1, December 18, 1967,

1 (a) Desai and Usgaonkar, *J. Ind. Chem. Soc.*, 1963, 40, 239.

(b). — and —, *Ibid.*, 1964, 41, 821.

2. Bendz, *Arkiv Kemi*, 1959, 14, 511; *C.A.*, 1960, 54, 10056.

3. Mitscher, Andres and McCrae, *Experientia*, 1964, 20 (5), 258; *C.A.*, 1964, 60, 15821.

4. Nogami, *J. Pharm. Soc. Japan*, 1941, 61, 56; *C.A.*, 1941, 35, 4764.

5. Matsui, Mori and Arasaki, *Agr. Biol. Chem.*, 1964, 28 (12), 896; *C.A.*, 1965, 62, 14614.

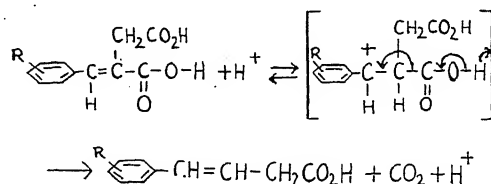
## ACID CATALYSED DECARBOXYLATION OF ITACONIC ACIDS

THE S<sub>E</sub>2 mechanism of decarboxylation of organic acids, where a proton displaces a carboxyl group, was suggested by Schenkel and Schenkel-Rudin<sup>1</sup> on basis of their work on anthracene-9-carboxylic acid. Later, Johnson and Heinz<sup>2</sup> showed that the electronic effects of substituents in the decarboxylation of substituted cinnamic acids were in accordance with this mechanism.

If the mechanism were of the S<sup>a</sup>2 type, then the presence of electron releasing groups should facilitate it, since the reaction proceeds through a carbonium ion intermediate<sup>2</sup>; hence acid decarboxylations of some itaconic acids were studied. Decarboxylations were conducted in a manner similar to that adopted by Johnson and Heinz,<sup>2</sup> using a large excess of refluxing CH<sub>3</sub>COOH : HBr (48%) : H<sub>2</sub>O :: 3 : 2 : 1 mixture.

In the case of substituted phenyl itaconic acids the reaction proceeded smoothly with evolution of nearly molal quantities of carbon dioxide, and the decarboxylation showed excellent first-order kinetics. Under identical conditions, for 4-methoxy, 3,4-methylenedioxy, and 3,4-dimethoxy itaconic acids the quantities of carbon dioxide collected were 22.3, 20.6, and 19.7 ml. per millimole of acid, and the first-order rates were 0.00207, 0.00141, and 0.00114 sec.<sup>-1</sup> respectively. [The parent phenyl itaconic acid (R=H), however, yielded only 18% of carbon dioxide and the reaction was very much slower than the others; similar behaviour for cinnamic acids have been noted.<sup>2</sup>]

The agreement of these reaction rates with Hammett's  $\sigma$  constants, -0.268, -0.159, -0.117 for the corresponding groups<sup>3</sup> gives a quantitative support to a carbonium ion transition state,<sup>2</sup> and the mechanism may be schematically written as below. Further, it reveals that it is reasonable to extend qualitatively (at least) the Hammett's constants to phenyl conjugated systems as in this case.



The itaconic acids used were prepared by the Stobbe condensation of the aldehyde and



dimethyl succinate using methanolic sodium methoxide.<sup>4</sup>

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Nagpur, January 22, 1968.

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1. Schenkel, H. and Schenkel-Rudin, M., *Helv. chim. Acta*, 1948, 31, 514.
2. Johnson, W. S. and Heinz, W. E., *J. Am. Chem. Soc.*, 1949, 71, 2913.
3. Jaffe, H. H., *Chem. Revs.*, 1953, 53, 222, 223, 244.
4. Benerjee, D. K. and Bagavant, G., *Proc. Ind. Acad. Sci.*, 1959, 50 A, 284.

### A COMPARATIVE STUDY OF THE NITROGENOUS CONSTITUENTS OF SOME LEGUMINOUS SEEDS

ALTHOUGH all leguminous seeds hitherto examined—edible as well as wild and uncultivated—have appreciable high protein content, their inclusion in animal nutrition has scrupulously been avoided. This is partly due to their unpleasant odour and taste but mainly due to the deleterious physiological effects which they can exert in the presence of anti-growth and other toxic factors if and when present. This investigation was undertaken with a view to explore the possibility of isolating the different protein fractions from such undesirable wild seed constituents in the pure form and to incorporate them in animal nutrition.

The following describes the distribution of nitrogen in the seeds of *Dolichos biflorus*, *Glycine hispida* (edible but not very popular), *Mucuna pruriens* and *Pithecellobium dulce* Benth. (wild and inedible) as well as the extraction, precipitation, fractionation and partial purification of their various protein components by simple methods.

Healthy and dry mature seeds of *Dolichos biflorus* and *Glycine hispida* were bought in Ranikhet, and *Mucuna pruriens* and *Pithecellobium dulce* seeds were bought locally. The seeds were powdered to 100 mesh, defatted with petroleum ether (B.P. 40–60°) and employed for all investigations.

The preliminary analyses, summarized in Table I, were carried out by methods referred in our previous communications.<sup>1–4</sup>

The effect of pH variation (0.2–10) on the extraction of seed-proteins was studied by employing solutions of HCl and NaOH of known concentration and pH. Weighed samples (ca 1 g.) in duplicate were mechanically shaken with the extractants (25 ml.) in Erlenmeyer flasks for 2 hours at room tem-

perature (30° ± 1°). The extracts were centrifuged and nitrogen was determined in 5 ml. of the clear supernatant.

TABLE I  
Chemical composition of some leguminous seeds

Constituents		<i>Dolichos biflorus</i>	<i>Glycine hispida</i>	<i>Pithecellobium dulce</i>	<i>Mucuna pruriens</i>
Moisture %	..	3.00	2.73	2.36	4.50
Ash %	..	3.06	5.22	3.00	4.19
Lipids %	..	2.02	9.64	11.69	8.64
Crude protein (N × 6.25)		27.62	52.80	24.40	27.56
Total soluble carbohydrate %		6.93	16.48	19.01	..

Figure 1 representing the variation of extraction of nitrogenous components of seed meals

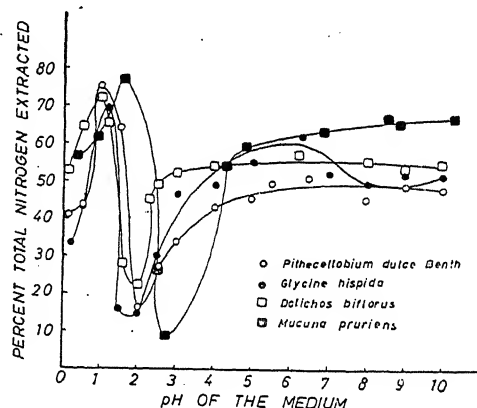


FIG. 1

with the change of pH suggests a method for their isolation. The nitrogenous compounds which mainly consist of proteins and some non-protein nitrogenous compounds (5–6%, Table II) can be maximally extracted with either HCl or NaOH solutions at appropriate pH and then precipitated by adjusting the pH of the medium to that of minimum extraction. However, it has been observed by us that these maximally extracted proteins do not get completely precipitated after pH adjustment due to the formation of NaCl which brings about the dissolution of globulins. Therefore, the simplest method for the isolation of seed proteins would be their extraction with NaCl solution at neutral pH and subsequent dialysis of the extract when globulin type of proteins would get precipitated leaving the other soluble ones in solution which could be recovered by suitable precipitants. The proteins thus isolated



seem to be of higher purity since they contain less non-protein materials than the samples of proteins obtained by the other method referred above.

TABLE II  
Distribution of total nitrogen in some  
leguminous seeds

	<i>Dolichos biflorus</i>	<i>Glycin hispida</i>	<i>Pithecel. lobatum dulz.</i>	<i>Mucuna purpurea</i>
Protein fractions—water soluble [Alb + Glob (A) + NFN]	69.90	71.03	70.58	79.50
Albumin ..	15.39	3.55	7.45	5.64
Globulin (A) ..	49.77	61.50	58.28	66.91
Globulin (B) (5% NaCl sol.)	13.19	6.21	9.25	16.31
NPN ..	4.73	5.97	4.85	6.95
Total Globulins ..	62.96	67.72	67.53	83.22
Prolamine (75% Ethanol sol.)	2.01	1.02	1.29	0.02
Glutelin (0.25% NaOH)	6.83	6.04	5.17	2.81
Residue ..	8.06	15.69	5.88	1.36

The fractionation of proteins was carried out by successive exhaustive extraction of accurately weighed seed powders (ca 3 g.) with glass-distilled water, NaCl (5%, w/v), ethanol (75%, v/v) and NaOH (0.25%, w/v) till the extracts were negative to biuret test. All the extracts were analysed for nitrogen and results were calculated as percentages of the total nitrogen content of the seed powders.

Extractions show that water solubilizes 70–80% of the total nitrogen which is of albumin, globulin and non-protein nitrogen combined origin. Globulins contribute the major fraction of proteins accounting for 63–83% of the total nitrogen, prolamine forms a small fraction and non-protein nitrogen amounts to 5–6%.

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## ON THE DEHYDRATION OF ETHYL ALCOHOL OVER ACTIVATED BAUXITE

THE vapour-phase dehydration of ethyl alcohol is a well-studied reaction.<sup>1,2</sup> However, data on a continuous run (particularly over bauxite) are rarely reported in literature.

The bauxite was first washed to remove clay material present and dried to remove free water. It was then taken in a platinum crucible batch by batch and activated at 900° C. to remove combined water and to increase its adsorptive power. The aluminium trihydrate in the bauxite, thus treated, is changed to a new crystalline form of alumina, known as  $\gamma$ -alumina<sup>3</sup> (cubic structure).

A continuous run for 16½ hours was conducted in a fluid-bed flow reactor at atmospheric pressure (using a stainless steel reactor tube 2" i.d. and 18" long). The catalyst used was activated bauxite made as above, its particle size being –65 + 80 TSS. The reaction was conducted at 450° C., ethyl alcohol flow rate being maintained at 110 gm./hr. After collecting about 220 l. gaseous product in the drum which had a capacity of 250 l., the run was temporarily discontinued, the drum emptied for making it available again for continuing the run. During the period that the run was temporarily discontinued the catalyst bed was kept heated and maintained at 300° C, thereby giving the bauxite no chance to absorb any moisture from outside atmosphere.

The conversion trend of ethyl alcohol to ethylene is given in Fig. 1. It can be seen from Fig. 1 that at the initial stage (up to 9 hours of run) the conversion (mole %) increased with time, thereafter remaining constant. Though the carbon deposited during the reaction is expected to decrease the catalyst activity, the increase in conversion, as is actually noticed, can be explained on the basis of moisture content in the catalyst employed. Brey and Krieger<sup>4</sup> report that for an alumina base catalyst to be most active for dehydration reaction it should have some optimum moisture content. However, when activating the catalyst at 900° C, it is explained that the same would be left with a moisture content much less than the optimum required as per Brey and Krieger. It is thought that during the reaction (at a much lower temperature) a slow activated adsorption of water would take place increasing its moisture content, which

1. Pant, R. and Kapur, A. S., *Ann. Biochem. Exptl. Med.*, 1963, **23**, 95.
2. — and —, *Ibid.*, 1963, **23**, 457.
3. — and —, *Naturwissenschaften*, 1963, **50**, 95.
4. — and Bishnoi, P. L., *Curr. Sci.*, 1967, **14**, 376.

might approach a value near the optimum level. The catalyst will then be the most active. This maximum activity may again suffer after a prolonged process period which may be due to carbon deposition. In the present run, however, this decrease was not noticed as the continuous run period was only 16½ hours duration.

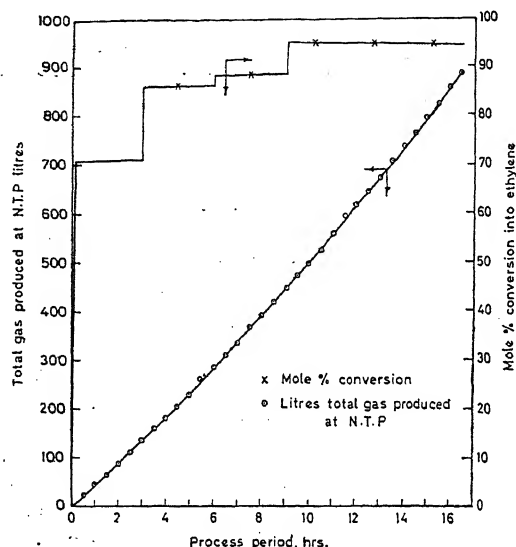


FIG. 1. Mole per cent conversion to ethylene and total gas produced (litres at N.T.P.) vs. process period.

The same trend was also observed when using a similarly treated alumina prepared synthetically from aluminium nitrate and ammonium hydroxide.

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## DISTRIBUTION OF SIALIC ACID IN THE GENITAL ORGANS OF MALE RHESUS MONKEYS: EFFECT OF CASTRATION AND REPLACEMENT THERAPY

THE presence of sialic acid has been demonstrated in the testis, seminal vesicles, prostate, semen and spermatozoa of men.<sup>1,2</sup> The semen and spermatozoa of several other mammalian species (rabbit, sheep, pig bull and dog) have also been reported to contain this substance. In rats the highest concentration of sialic acid is observed in the cauda epididymis;<sup>7,8</sup> castration has virtually no effect on sialic acid concentration of the genital organs,<sup>8</sup> even though its level in the epididymis has been reported to increase steadily during puberty.<sup>9</sup> Accordingly, it has been deemed worthwhile to investigate the extent to which the sialic acid concentration of the genital organs of male rhesus monkeys (*Macaca mulatta*) is androgen dependent.

Adult male rhesus monkeys (9–11 kg.) of the Institute primate colony were used in this investigation. They were maintained under uniform husbandry conditions throughout the experimental period. The castrated animals were given a rest period of 30 days before commencement of hormone therapy. The dose of testosterone propionate (TP) was 2 mg. (in 2 ml. sterile olive oil) daily per monkey by the intramuscular route for 21 days. The intact control and castrated groups received the solvent alone in a similar manner.

All animals were sacrificed on the day following the last (TP or solvent) injection. The genital organs were dissected out and weighed accurately. Sialic acid was estimated by procedures described previously.<sup>3,4,7</sup>

It will be evident from the results presented in Table I that in intact controls testis had the lowest concentration of sialic acid and epididymis (caput and corpus) the highest; the level in cauda epididymis was lower than that of the corpus portion ( $P < 0.02$ ). The seminal vesicle and the prostate showed about the same concentration. Castration or TP therapy had no statistically significant effect on sialic acid level of the genital organs (Table I). However, it was interesting that while the pattern of quantitative distribution of sialic acid in the epididymis (caput, corpus and cauda) did not alter after castration, the concentration in the prostate recorded a somewhat higher value than that of the seminal

1. Roy, N. C. and Bose, N. K., "Kinetics and catalytic dehydration of ethanol on activated alumina," *Trans. I.I.Ch.E.*, XI (1958–59).
2. Pargal, H. K. and Kanga, S. H., "Deterioration of the activity of activated alumina during the dehydration of ethanol to ethylene," *Chem. Age of India*, 1964, 15 (1), 117.
3. Kirk, R. E. and Othmer, D. F., *Encyclopedia of Chemical Technology*, Vol. 1, 1940. The Interscience Encyclopedia, Inc., New York, 1947.
4. Brey, W. S. and Krieger, K. A., "The surface area and catalytic activity of aluminium oxide," *J. Am. Chem. Soc.*, 1947, 71, 3637.

TABLE I

Effect of castration and replacement therapy on sialic acid concentration of the genital organs of male rhesus monkey

Status	Sialic acid (Mg./100 gm.)					
	Testis	Caput epididymis	Corpus epididymis	Cauda epididymis	Seminal vesicle	Prostate
Control (4)*	13.4 <sup>†</sup> (10.7-15.4)	51.0 (40.5-55.7)	48.6 (42.1-61.1)	37.1 (33.3-43.7)	20.5 (17.2-23.3)	24.3 (19.0-27.8)
Castrated (4) ..	..	49.9 (45.0-53.2)	50.1 (42.2-60.8)	39.9 (31.2-45.6)	19.72 (17.0-22.4)	26.5 (21.1-29.3)
Castrated + testosterone propionate (4)	..	48.8 (42.3-55.7)	47.0 (42.1-49.8)	40.0 (33.9-45.7)	21.2 (15.2-23.4)	25.8 (21.0-32.1)

\* No. of animals.    † Mean with range in parenthesis.

vesicles ( $P < 0.05$ ). This was, however, not the case in the TP-treated group.

It thus appears that as in rats,<sup>7,8</sup> the epididymis of monkeys shows the highest concentration of sialic acid. However, in contrast to rats,<sup>7,8</sup> the level in the caput and the corpus portions is higher than that of cauda. The apparent non-responsiveness of sialic acid concentration of the genital organs to castration and TP therapy in both species, suggests that the level of this constituent is not under androgenic control of the testis.

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Central Drug Res. Inst.,                      A. R. BOSE.  
Lucknow (Com. No. 1244),                      AMIYA B. KAR.  
January 29, 1968.

1. Odin, I., *Acta Chem. Scand.*, 1955, **9**, 1235.
2. Warren, L., *J. Clin. Invest.*, 1959, **38**, 755.
3. Svennerholm, L., *Acta Chem. Scand.*, 1958, **12**, 547.
4. Gottschalk, A., *The Chemistry and Biology of Sialic Acid and Related Substances*, Cambridge University Press, p. 12.
5. Hudson, M. T., Wetterson, R. Jr. and Kuferberg, A. B., *J. Reprod. Fertl.*, 1965, **9**, 189.
6. Hartree, E. and Srivastava, P. N., *Ibid.*, 1965, **9**, 47.
7. Bose, A. R., Kar, A. B. and Dasgupta, P. R., *Curr. Sci.*, 1966, **35**, 336.
8. Fournier, S., *C.R. Soc. Biol.*, 1966, **160**, 1089.
9. Peyre, A. and Laporte, P., *C.R. Acad. Sci. (Paris)*, 1966, **263**, 1872.

#### EFFECT OF ADRENERGIC BETA RECEPTOR BLOCKING DRUGS ON MONOAMINE OXIDASE ACTIVITY

ADRENERGIC beta receptor blocking drugs and their isomers produce varied effects on the central nervous system by mechanisms still unknown. *n*-isopropyl para-nitrophenyl ethanolamine; D(l) INPEA and its inert isomer L(d) INPEA have been observed to produce central excitatory effects.<sup>5</sup> As opposed to these, propranolol<sup>1,5,6</sup> and *n*-isopropyl-B (4-methanesulphonamidophenyl) ethanolamine (MJ 1999)<sup>4</sup> depress the central nervous system. Since monoamines as well as their degrading enzyme, monoamine oxidase play an important part in the mediation of brain functions it was considered worthwhile to study the effect of the above adrenergic beta receptor blocking drugs on monoamine oxidase activity.

Monoamine oxidase activity was estimated manometrically in Warburg's apparatus by the method of Creasey.<sup>2</sup> 0.2 ml. of 2M tyramine was used as the substrate, and 2 ml. of a 1:10 homogenate of fresh rat liver in phosphate buffer (pH 7.4), was employed as the enzyme preparation. The drugs, D(l) INPEA, L(d) INPEA (Selvi and Co.), propranolol (I.C.I.) and MJ 1999 (Mead Johnson and Co.) were added to the homogenate in the flasks and incubated for 15 minutes prior to the addition of the substrate contained in the sidearm. The effect of these on MAO activity was compared with that of nialamide (Pfizer), a known inhibitor of MAO.

Table I reveals that D(l) INPEA has the most potent inhibitory effect on MAO which is comparable to that of nialamide. L(d) INPEA, in comparison, is a much weaker

inhibitor of MAO and also possesses lesser stimulant effect on the brain than the laevo rotatory optical isomer (unpublished observations). It can therefore be presumed that the property of isomers of INPEA to stimulate the central nervous system may be related to the inhibition of MAO. Propranolol also shows slight inhibition of MAO which is similar to the observation of Greeff and Wagner.<sup>3</sup> Paradoxically, this drug causes depression of the central nervous system, which may be due to some other mechanism of action.

TABLE I

Effect of adrenergic beta receptor blocking drugs on monoamine oxidase activity of rat liver, in vitro

Drugs	Dose ( $\mu$ g./ml.)	No. of observations	Units* of MAO activity during first 30 minutes $\pm$ S.E.	Per cent inhibition	'p' value
Control	..	18	4.2 $\pm$ 0.31	..	..
Nialamide	37	8	2.6 $\pm$ 0.23	38	< 0.01
	71.5	8	2.2 $\pm$ 0.2	47.6	< 0.01
D-INPEA	37	12	2.8 $\pm$ 0.61	33.33	< 0.05
	71.5	10	2.4 $\pm$ 0.18	42.3	< 0.01
L-INPEA	37	10	3.4 $\pm$ 0.351	19	< 0.05
	71.5	10	3 $\pm$ 0.41	28	< 0.05
MJ 1999	37	8	4.2 $\pm$ 0.4	0	> 0.9
	1	8	4 $\pm$ 0.13	4.7	> 0.6
Propranolol	37.5	8	3.9 $\pm$ 0.26	5.2	> 0.3
	71.5	8	3.2 $\pm$ 0.17	23.8	< 0.05

\* 1 unit activity = 1  $\mu$  litre of oxygen consumed per hour per gram of enzyme source.

It is interesting to observe that the alteration in the isomeric state of INPEA leading to an increase in beta receptor blocking property also confers to the compound a greater enzyme inhibitory potency. However, MJ 1999, a specific adrenergic beta receptor blocking drug,<sup>4</sup> does not cause any inhibition of MAO.

The present study reveals that although inhibition of MAO is not a common property which is shared by all adrenergic beta receptor blocking drugs, still it may be concerned with the central excitatory effect of INPEA.

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1. Agarwal, S. L. and Bose Deepak, *Brit. J. Pharmacol.*, 1967, **30**, 349.
2. Creasey, N. H., *Biochem. J.*, 1956, **64**, 178.
3. Greeff, K. and Wagner, J., *Naturwissenschaften*, 1966, **53**, 40 (Ger).
4. Lish, P. M., Weikel, J. H. and Dungan, K. W., *J. Pharm. Exp. Ther.*, 1965, **149**, 161.
5. Murmann, W., Almirante, L. and Saccani-Guelfi, M., *J. Pharm. Pharmacol.*, 1966, **18**, 317.
6. Sinha, J. N., Srimal, R. C., Jaju, B. P. and Bhargava K. P., *Ind. J. Physiol. Pharmacol.*, 1966, **10**, 20.

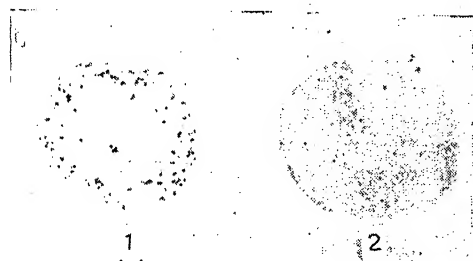
### DIAGNOSIS OF SPIROCHAETOSIS OF POULTRY BY SLIDE AGGLUTINATION AND SPIROCHAETE IMMOBILIZATION TESTS

DIAGNOSIS of spirochaetosis of poultry has been made by demonstrating *Borrelia anserina*, the causative organism of the disease in blood and tissues in the acute stage by ordinary microscopy, dark field microscopy (Nobrega and Reis, 1947, cited by Snoeyenbos, 1965) and fluorescent antibody technique (Gross and Ball, 1964). Immobilizing antibodies have been demonstrated in the treated and recovered birds (Levaditi *et al.*, 1952). In the present note the authors report quick plate agglutination and spirochaete immobilization tests which can be employed to detect the micro-organisms in the acute phase of the disease and the antibodies in poultry flocks where infection might have passed unnoticed.

The antigen was separated from the blood of artificially infected birds usually on fourth day of inoculation when the number of spirochaetes was maximum in the blood circulation. The blood was collected in sterile citrated solution and its volume was increased two to three times with normal saline. Red blood suspension was thoroughly mixed and centrifuged at 500 rpm for 5 minutes to settle the blood cells. The supernatant containing most of the micro-organisms was collected in a separate test-tube and the sedimented red blood cells were resuspended in normal saline solution for centrifugation at the same speed and time for recollecting the supernatant. The pooled supernatant was centrifuged at 3,500 rpm for 15 minutes. The micro-organisms, settled at the bottom of the tube, were suspended in 0.5% carbol saline to match McFarland's opacity tube No. 4 which constituted the antigen for slide agglutination test. The antigen was coloured with 1% alcoholic solution of crystal violet at the rate of 0.03%.

The test was conducted by adding two loopful (4 mm. diameter) of the coloured antigen

and one loopful of the serum on a clean glass slide. The antigen and the serum were mixed with the loop and then rotated for 30 seconds in a circular fashion. Positive reactions appeared within 10 to 15 seconds and were detected in the form of distinct clumps (Fig. 1). In case of negative reaction no clump formation occurred and the antigen-serum mixture remained uniformly cloudy (Fig. 2). All the



FIGS 1-2. Fig. 1. A positive antigen-antibody reaction showing distinct clump formation. Fig. 2. A negative antigen-antibody reaction without any clump formation.

serum samples from convalescent or hyper-immunized birds gave strong positive reaction while the serum samples from birds having no history of spirochaetosis gave negative reaction. The clumping of the organisms with positive serum was stronger when fresh live antigen was used. This when observed under the microscope showed complete immobilization of the motile organisms. Reaction with normal serum did not exhibit such a phenomenon.

The rapid plate agglutination and immobilization tests can easily be applied for detecting the organisms in the blood in the acute phase of the disease and also for the detection of antibodies in the recovered birds. The tests are very simple, quick, sensitive and specific, and can be performed under ordinary conditions needing no elaborate and costly equipments.

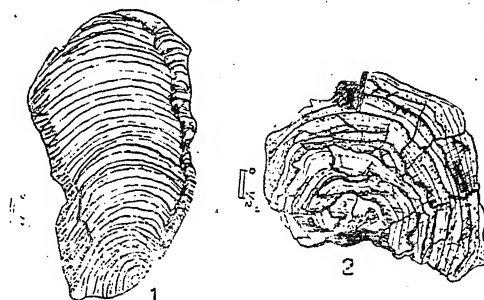
The authors are grateful to Sri. S. B. V. Rao, I.V.R.I., Izatnagar, for supplying blood from spirochaete infected fowls and to Major C. V. G. Choudary, Principal, for providing the necessary facilities to carry out the work.

Department of Bacteriology, K. C. VERMA.  
U.P. College of Veterinary B. S. MALIK.  
Science and Animal Husbandry,  
Mathura (U.P.), December 5, 1967.

2. Levaditi, G., Vaisman, A. and Hamelin, A., *Imm. Inst. Pasteur*, 1952, **43**, 260.
3. Snoeyenbos, G. H., *Diseases of Poultry*, Edited by Biester, H. E. and Schwarte, L. H., Iowa State University Press, Ames, Iowa, U.S.A., 5th edition, 1965.

# STROMATOLITIC STRUCTURES FROM THE TYPE AREA OF BIJAWAR ROCKS CHATTARPUR DISTRICT, MADHYA PRADESH (INDIA)

The authors report the occurrence of stromatolitic structure (Fig. 1) for the first time from the Bijawar Pre-Cambrian strata. It has been discovered in the cherty quartzites exposed on the scarps of Gorahi hill, situated at a distance of nearly one and a half miles S.W. of Dahi village ( $24^{\circ} 37' 30''$  :  $79^{\circ} 33'$ ). Here the cherty quartzites are thinly bedded, nearly 15-20 feet in thickness and they dip towards the S./S.S.E. with an angle varying from  $12^{\circ}$  to  $20^{\circ}$ . The cherty quartzites form the bottom bed of the Lower Bijawar sequence (B. Das and S. U. Khan, 1967).



FIGS. 1-2

The stromatolites occur as isolated individuals. The specimen illustrated is rather weathered and has a ferruginous appearance. The only discernible structure in hand specimen is innumerable transverse upwardly convex laminations. The laminae of the upper portion are more or less parallel to the upper surface whereas towards the base they become more concentric and tend to converge at their ends. The laminae are from half to one millimeter distance apart. Minute vesicles are also observed at the junction of a few of the laminae. These are arranged in a linear fashion, maintaining parallelism with the upwardly convex lamination all along the curvature. This vesicular linear arrangement is to be seen from the base of the structure upto the upper surface at irregular intervals. The upper surface is arched, with a dome-like

1. Gross, W. H. and Ball, M. R., *Am. J. Vet. Res.*, 1964, **25**, 1734.

appearance. Its hemispherical diameter is nearly 2.5 inches. The height of the specimen, from the base upto the upper domal surface, is nearly 5 inches.

Generally stromatolitic structures are preserved in limestones and dolomites. But in this case the structure is associated with thinly laminated cherty quartzites. A similar example has also been reported from the Ironwood formation (Upper Huronian) of the Gogebic Range (Twenhofel, 1919, p. 347).

Another sample of possible stromatolitic structure (Fig. 2) has also been collected from an exposure of quartzitic sandstone belonging to the upper Bijawars situated at a distance of nearly two and a half miles to the south of Pathra village ( $24^{\circ} 33' : 79^{\circ} 36'$ ). The specimen consists of cherty sandstone. The structure is circular in shape and gives an appearance of projected concentric lamination. The width of the individual laminæ varies from 0.1 cm. to 0.5 cm. The diameter is nearly 12 cm. and the vertical thickness of the sample is nearly 2.5 cm. The structure is preserved on the upper surface of the bed. Nearly four or five such structures are present within an area of 5 sq. ft.

Regarding the origin and the stratigraphic significance of these structures some more specific observations of such stromatolites and their abundance in the formation is needed. The authors could not find any calcareous material when the sample was treated with HCl, not even when the sample was left in HCl for a considerable time. If, however, its origin is considered as due to algal action (Twenhofel, *op. cit.*, p. 341) the discovery of stromatolitic structures in the Bijawar rocks is of importance, as it indicates the existence of algæ in the sea of the region in pre-Vindhyan times. It is quite likely that they might have played a significant part in building these sedimentary rocks (e.g., bedded cherts, limestones, etc.).

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University of Saugar,  
Saugar (M.P.), November 20, 1967.

## FOLIAR APPLICATION OF $C^{14}$ -GLUCOSE AND $P^{32}$ -PHOSPHATE AND DETECTION OF RADIOACTIVITY IN THE ROOT EXUDATE OF SORGHUM

It is well understood that certain organic and inorganic substances applied on the foliage are absorbed and translocated to various parts by the plant system, either as such or in modified forms. Mitchell *et al.*<sup>1</sup> reported on variations in the amounts of chemicals translocated down the plant and exuded through the root in an unaltered form, when  $C^{14}$  labelled exogenous growth regulators were applied on the foliage. The importance of our understanding the qualitative and quantitative variations in the root exudates under the influence of foliar treatments with chemicals in relation to rhizosphere microflora has been stressed by Rovira.<sup>2</sup> The present report is on the incorporation of radioactive carbon and phosphorus in the root exudates, when applied on the foliage.

Sorghum plants (*Sorghum vulgare* Pers.) were grown under aseptic root conditions in the 'exudation apparatus' developed by the authors.<sup>3</sup> Uniformly labelled ( $C^{14}$ )-d-glucose obtained from Radio-Chemical Centre, Amersham, England, was used for foliar application. 0.12 mg. of the radioactive glucose of 0.5 mc. activity was eluted from the filter-paper (on which it was originally placed by the manufacturers) with 5 ml. of double-distilled water. To 1 ml. of the solution with total activity of 0.1 mc. one drop of 'teepol' was added as detergent. This was applied to each plant by placing a strip of filter-paper, 0.5 cm. wide and 1-3 cm. long, with a central slit, on the leaf surface of 30-day old sorghum plants, and adding drop by drop the entire 1 ml. quantity. When the filter-paper strip had dried additional quantities of double-distilled water were added to leach out the chemical. 36 hr. after the chemical was applied, the root exudates were collected and the plants removed from the exudation apparatus, for monitoring radioactivity. The radioactive phosphorus, in the form of  $Na_2HP^{32}O_4$ , obtained from Bhabha Atomic Research Centre, Trombay, India, was also applied in a similar manner after diluting the chemical to obtain an activity of  $1 \mu\text{C}/\text{ml}$ . On each plant 2 ml. of this solution was applied.

The exudates collected from the treated and untreated check plants were passed through ion-exchange resin columns and separated into different fractions, following the procedure reported elsewhere by the authors.<sup>4</sup> Autoradiograms of the chromatograms of the fractions

1. Das, B. and Khan, S. U., *Curr. Sci.*, 1967, 36, 420.
2. Twenhofel, W. H., *Amer. Jour. Sci.*, 1919, 48, Series 4, 339.

were prepared as per the procedure of Comar.<sup>5</sup> To examine the radioactivity in the anionic fractions, the Dowex resin column was leached with 100 ml. of 5N HCl and the eluant evaporated *in vacuo* and the activity monitored.

The results on the distribution of activity in the C<sup>14</sup> and P<sup>32</sup> treated plants are summarized in Table I. The chromatographic assays followed by autoradiograms revealed that glucose, fructose and another unidentified carbohydrate and glutamic acid, aspartic acid and another ninhydrin-positive compound were labelled through the C<sup>14</sup> treatment. In the P<sup>32</sup>-treated plants the activity was retained in the leaf, shoot and root and only the inorganic (anionic) fraction of the root exudate carried the activity. Chemical tests also confirmed the presence of phosphate in the inorganic fraction of the root exudate.

TABLE I  
Detection of foliar applied radioactivity in the various plant parts and root exudate fractions of sorghum

(Activity expressed as c.p.m. recorded 36 hr. after application; results represent activity in 1 g. of moisture-free samples and average of 20 counts for each sample)

Sample	C <sup>14</sup>	P <sup>32</sup>
Leaf	1550	630
Shoot	396	360
Root	612	450
Root exudate fractions:		
Amino-acids	648	*
Sugars	864	*
Inorganic substances	*	720

\* No detectable activity.

Though the fate and metabolism of the foliar applied nutrients have been studied using tagged chemicals by several workers, little work has been carried out on the passage of activity into the root exudates. The present studies indicate that C<sup>14</sup>-glucose and P<sup>32</sup>-phosphate when applied on the leaves of sorghum plants, are readily absorbed and translocated to other plant parts and also exuded through the roots. Earlier, Rangaswami and Govindarajan<sup>6</sup> reported on the detection of radioactivity in the root exudates of tomato plants treated with C<sup>14</sup> glucose on the foliage. The incorporation of C<sup>14</sup> activity in glucose, fructose, glutamic acid, aspartic acid and two other unknown molecules indicates ready utilization of the foliar applied glucose for different biochemical processes by the plant. The results with P<sup>32</sup> confirm the report of Wittwer and Teubner<sup>7</sup> on the utilization of phosphate in sugar, lipid and protein metabo-

lisms by the plant. The retention of P<sup>32</sup> in various plant parts and release of the activity through inorganic phosphate have been reported by other workers using different plant species.<sup>8,9</sup>

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Microbiology Lab., A. BALASUBRAMANIAN.  
University of Agri. Sci., G. RANGASWAMI.  
Bangalore-24,  
November 13, 1967.

1. Mitchell, J. W., Linder, P. J. and Robinson, M. B., *Plant Physiol.* (Suppl.), 1961, 36.
2. Rovira, A. D., In: *Ecology of Soil-borne Plant Pathogens*, Eds. K. F. Baker, and W. C. Snyder, Univ. Calif. Press, Berkeley, U.S.A., 1965.
3. Balasubramanian, A. and Rangaswami, G., *Mysore J. Agric. Sci.*, 1967, 1, 233.
4. — and —, *Plant and Soil* (sent for publication).
5. Comar, C. L., *Radioisotopes in Biology and Agriculture*, McGraw-Hill Book Co., New York, 1955.
6. Rangaswami, G. and Govindarajan, T. S., *Curr. Sci.*, 1964, 33, 138.
7. Wittwer, S. H. and Teubner, F. G., *Plant Physiol.*, 1959, 10, 13.
8. Oliver, W. F., *Sci. Agri.*, 1952, 32, 427.
9. Nikolaev, G. V., *Faistol. Rast.*, 1963, 10, 441.

## A NEW RECORD OF *PETALOPHYLLUM* *INDICUM* KASH. FROM WESTERN GHATS

Five species of *Petalophyllum* are known in literature and their distribution is as follows: *P. indicum* Kash., Northern India, Pakistan, *P. ralfsii* (Wilson) G., Britain, Hibernia, *P. lamellatum* Lindb., Britain (Stephani, considered it as synonym of *P. ralfsii*),<sup>4</sup> *P. presiaisi*, Australia, and *P. bolivianum* Schiffn., Bolivia.

Till the present collection was made, *P. indicum* was only reported from the banks of the Ravi at Lahore and the Beas at Beas, in the Punjab. Kachroo (in lit.) has suggested that the species may be also present higher up in the catchment areas of these two rivers, basing his experience on *Riccia frostii* (*R. sanguinea*) which has followed similar river dispersal in the Kashmir valley and the Assam plains.

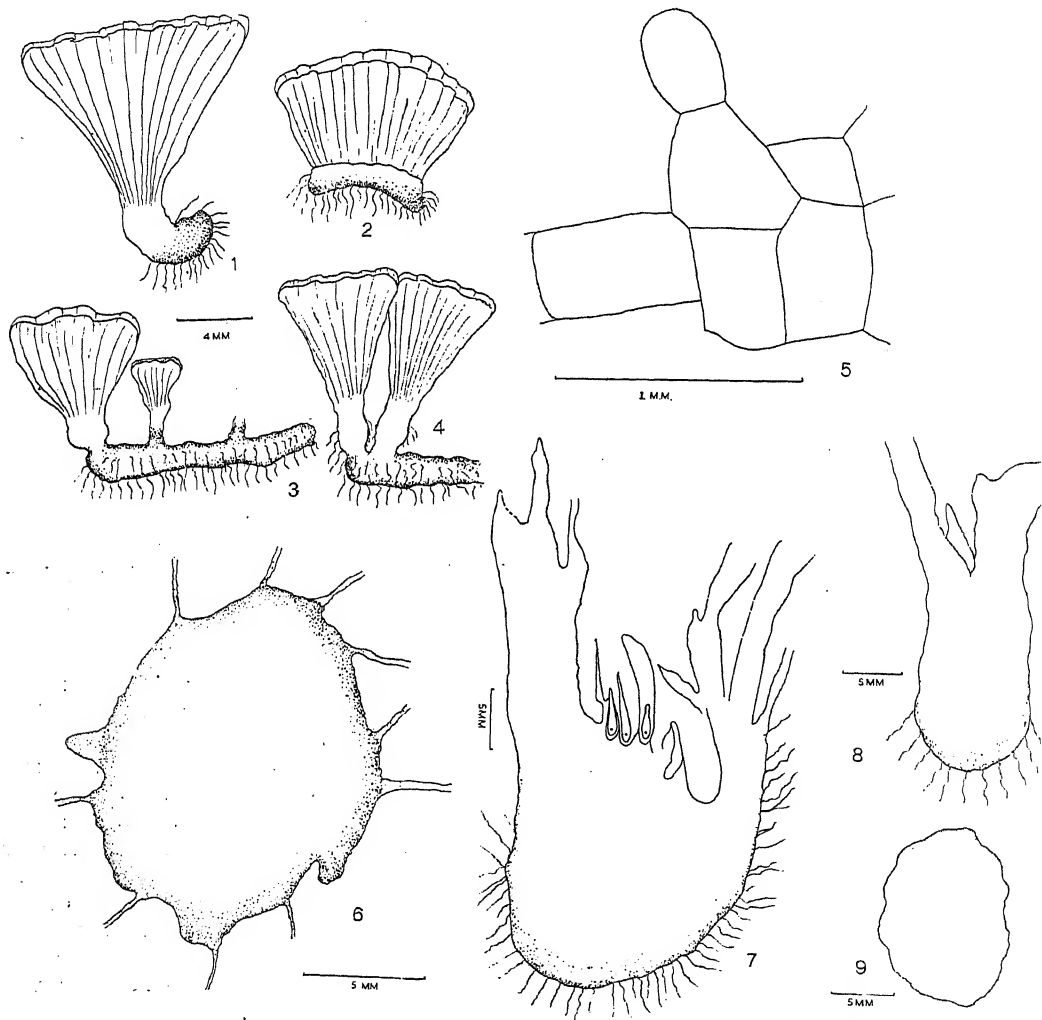
Purandhar, a hill 40 km. south-east of Poona, ca 1387 m. high in the Western Ghats, has a deciduous type of vegetation. *Petalophyllum indicum* grows here luxuriantly in association with grasses, mosses and *Anthoceros*. The other common genera of hepaticae

are *Asterella*, *Plagiochasma*, *Targionia*, *Cyathodium*, *Riccia*, *Fossombronina*, *Phaeoceros*, etc.

The average rainfall is 139–150 cm. (June to September) and the relative humidity is 90% during the monsoons and about 70% in the dry months. The annual maximum temperature is 28°C and the minimum 16°C.

The thalli of *Petalophyllum indicum* growing at Purandhar are bright green, in dense cluster, or patches, rarely singly on damp shady places, on slopes. The plants appear in the first week of June. They are dioecious; male

thalli (5–8 mm. long and 4–6 mm. broad) are smaller than the female ones (8–14 mm. long and 6–12 mm. broad). The plants (Figs. 1, 3) have on the posterior side a solid subterranean cylindrical stalk growing horizontally or obliquely. The stalk is generally 2–5 mm. long and 1–2 mm. in diameter, may be branched (Fig. 3); branches negatively geotropic, usually arises in one plane almost at right angle to the axis of stalk. Occasionally some of these branches may become thickened and bear wings (Fig. 3). The apical region of the stalk



FIGS. 1–9. *Petalophyllum indicum*. Fig. 1. Simple funnel-shaped plant with curved cylindrical stalk. Fig. 2. Plant with flattened stalk prominently projected ventrally with ascending wings. Fig. 3. Horizontal underground branched stalk bearing two funnels. Fig. 4. Stalk forked at the apex, each fork bearing a funnel. Fig. 5. Terminal cell of the lamella. Fig. 6. T.S. subterranean stalk showing peripheral mycorrhiza (shaded). Fig. 7. Section of the plant in Fig. 2 in vertical plane showing archegonia on the anterior and basal mycorrhiza (shaded). Fig. 8. V.S. plant in Fig. 3 showing the basal region with mycorrhiza (shaded). Fig. 9. T.S. stalk of plant in Fig. 1, just below the wing.



turns upward, becomes thick rounded, cylindrical or gradually flattens and bears lateral wings. Sometimes the stalk forks at the apex and each fork bears ascending fan-like wings (Fig. 4). Rhizoids are smooth-walled, present all round the stalk, though more numerous on basal region. The wings are found mostly ascending from the thickened region; consequently, plants often appear as erect, radial and funnel-shaped (Fig. 1). In very few cases wings prostrate. The margin of the wings is undulate. The wings bear on its dorsal surface numerous erect lamellæ. The orientation of lamellæ is similar to that described by Mehra and Vashisht.<sup>2</sup>

The presence of subterranean stalk suggests that the plants have developed from tubers—the perennating organs.

The cylindrical stalk in cross-section is 20–25 cells across, of uniform parenchymatous cells; those in the peripheral region bear mycorrhiza as in *Petalophyllum ralfsii*.<sup>1</sup> In the underground stalk, the fungal hyphæ attack many layers of peripheral cells however, the central region is devoid of any hyphæ (Fig. 6). The thickened region below the wings have micorrhizæ in one or two outermost layers of the periphery (Fig. 9). The hyphæ are not found in the anterior portion and the wings. The wings are many-layered (6–8) at base and one-celled at margin. The wing cells are polygonal but slightly elongated near the midrib, average size being  $31-47 \mu \times 51-57 \mu$ . Lamellæ one-celled thick, 10–18 cells high with undulating free margin. The terminal cell of the lamella oval-papilliform (Fig. 5) measuring  $28-30 \mu \times 25-42 \mu$ . Antheridia scattered on anterior side. Archegonia in groups of 3–8 on midrib surrounded by involucre bracts. Sporophytes not observed.

The Purandhar form comes very near *P. indicum* but shows some ecological differences from the Beas form (Table I) as described by Mehra and Vashisht.<sup>2</sup> A comparative study of the various species of the genus *Petalophyllum* is in progress with a view to define properly the taxonomic limits of the various species; and also comment on Schuster's<sup>3</sup> proposal to separate *Petalophyllum* from *Fossombronina* into a new family *Petalophyllaceæ*.

It is of interest that the species has not been collected from Pachmari by Pande who visited the place several times. The present record extends southwards the range of this species in India.

TABLE I

Purandhar form	Beas form
1. Plants large (upto 1.4 cm.)	Plants smaller (upto 1cm.)
2. Stalk prominent (1–2 mm. diameter)	Not prominent
3. Wings normally erect	Wings usually prostrate
4. Grows in clusters or patches, very rarely singly	Normally singly, rarely in patches
5. Perennating by tuberous stalk	Also by tubers
6. Stalk without internal differentiation but mycorrhiza confined to peripheral cells as in <i>P. ralfsii</i> (Cavers, 1911)	Stalk without internal differentiation but all cells may be mycorrhizal
7. Apical cell of lamellæ oval-papilliform	Shape not described

Thanks are due to Prof. P. N. Mehra (Chandigarh) for identification of the species and to Dr. P. Kachroo (New Delhi) for encouragement.

Dept of Botany,

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Udaipur (India), July 11, 1967.

1. Cavers, F., *Acta Phytol.* (Reprint), 1911, 4, 1.
2. Mehra, P. N. and Vashisht, B. R., *Bryologist*, 1950, 53, 89.
3. Schuster, J. M., *Amer. Midl. Nat.*, 1953, 49 (2), 575.
4. Stephani, F., *Species Hepaticarum* (1900), 1924, 1, 6, Geneva.

#### PRECOCIOUS GERMINATION OF SPORES IN *HAPLOCLADIUM SUBULACEUM* (MITT.) BROTH. AND *FORSTROEMIA INCLUSA* CARD. AND DIX.

PRECOCIOUS germination of spores is known to occur in a few mosses, such as, *Cleistostoma ambigua*, *Cryphaea macrospora*, *Synodontia cochlearifolia* and *Cinclidotus fontinaloides*. While studying Kumaon mosses, the authors came across two more instances, one in *Haplocladium subulaceum* and the other in *Forstroemia inclusa*. Spores in these mosses were found germinating within their open capsules on green plants. In *F. inclusa*, the protonemal filaments remained short and unbranched (Fig. 1, A), but in *H. subulaceum* these were short to quite long, uniseriate, branched or unbranched. Branches in the latter could arise anywhere and every filament ended in a short elliptical cell containing more prominent and larger number of chloroplast bodies than in the rest of the cells (Fig. 1, B). Fate of these cells has not yet been ascertained.

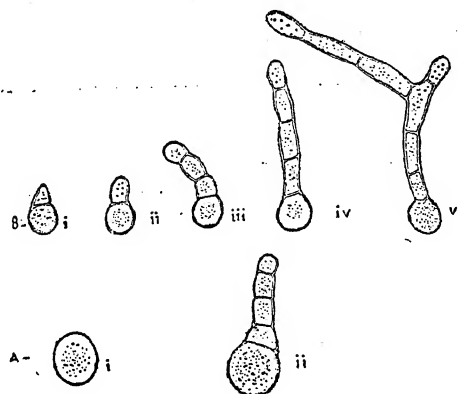


FIG. 1. Different stages of germination of spores within capsule. A—*F. inclusa*, i-ii; B—*H. subulaceum*, i-v.

Germination of spores within the capsule after the fall of operculum indicates that light is possibly an important factor. This is also borne out by the development of green protonemal filaments. Another conclusion that can be drawn is that the spores in mosses like *F. inclusa* or *H. subulaceum* possess a certain degree of independence. At least their initial growth is possible without drawing nutrients from the substratum.

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C.M.P. Degree College, J. P. SRIVASTAVA.  
Allahabad, June 15, 1967.

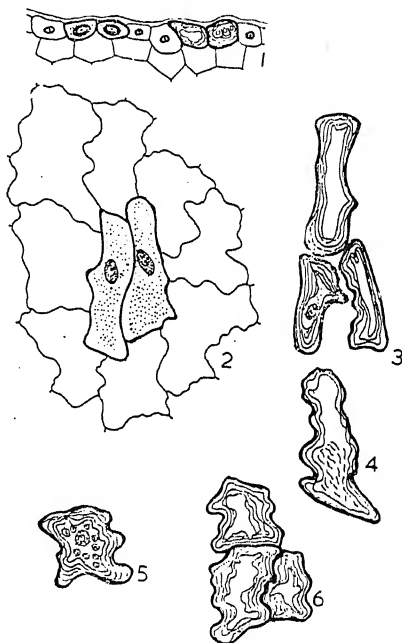
#### OCCURRENCE OF EPIDERMAL SCLEREIDS IN THE PETALS OF *IPOMOEA OBSCURA* (L.) KER-GAWL.

ACCORDING to Metcalfe and Chalk<sup>1</sup> a row of very characteristic 'spicular cells' occurs sporadically in the palisade and spongy portions of the mesophyll, particularly in the leaf of *Ipomoea* and occasionally in a few other genera of the family Convolvulaceae. During the course of anatomical and morphological studies in the genus *Ipomoea* the author observed the occurrence of sclereids in the upper epidermis of the petals of *Ipomoea obscura*. As far as the author is aware there is no reference to the occurrence and ontogeny of these sclereids. The present note describes their structure and ontogeny.

The epidermal cells are polygonal, isodiametric or elongated and have wavy anticlinal walls. The stomata are present on the lower epidermis and on the upper epidermis the sclereids are either solitary or in groups of 2-3. The sclereid shows a thick stratified cell wall and a lumen of irregular width. It is of two types: rod-like with wavy outline (Figs. 3 and 4) and polygonal or isodiametric

(Figs. 5 and 6). In transection the sclereids appear oval or fusiform (Fig. 1). They also contain small spherical crystals of calcium oxalate.

During the ontogeny a few of the epidermal cells differentiate as sclereid initials (Fig. 2). They are either solitary or in groups of 2-3 (Fig. 2). They have prominent nuclei and dense cytoplasm. Gradually the cells begin to show sclerosis (Fig. 3) resulting in thick striated cell walls. Ultimately the nuclei degenerate and the cytoplasm disappears (Fig. 6). Occasionally the nucleus and the cytoplasm persist (Fig. 5). The pits have not been observed.



FIGS. 1-6. *Ipomoea obscura* (L.) Ker-Gawl (Figs. 1-6,  $\times 650$ ). Fig. 1. Sclereids and sclereid initials in transection. Fig. 2. Sclereid initials in surface view of the epidermis. Fig. 3. Group of rod-like sclereids (Note nucleus and cytoplasm in one of the sclereids). Fig. 4. Solitary rod-like sclereid. Fig. 5. Solitary polygonal sclereid (Note nucleus, cytoplasm and small spherical crystals). Fig. 6. Group of polygonal sclereids.

The author is grateful to Dr. T. Ananda Rao for critically reading the manuscript. Thanks are due to Messrs. Abraham Raju, B. Vijay Gopal, T. N. R. C. Kurup and Miss N. V. Annamma for their help.

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Vallabh Vidyanagar,  
Gujarat, October 17, 1967.

1. Metcalfe, C. R. and Chalk, L., *Anatomy of Dicotyledons*, Clarendon Press, Oxford, 1950, 2.

## REVIEWS AND NOTICES OF BOOKS

**Separation Techniques in Chemistry and Biochemistry** (Vol. 1). Edited by Roy A. Keller. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1967. Pp. xvi + 415. Price \$12.75.

The Nineteenth Annual Summer Symposium on Analytical Chemistry, entitled "Separation Techniques," was held at the University of Alberta, Edmonton, Alberta, Canada, in June 1966. This symposium, sponsored by the Division of Analytical Chemistry of the American Chemical Society and *Analytical Chemistry*, was the first analytical symposium held outside of the United States. A total of twenty-eight interdisciplinary papers were presented during the two and a half days of the symposium. The majority of these have appeared in a number of issues of *Separation Science*.

The titles of the contributions to this volume are: Separation, Identification, and Estimation of Human Steroid Hormones and their Metabolites; Applications to Adrenocortical Steroids; Quantitative Analysis of the Twenty Natural Protein Amino Acids by Gas-Liquid Chromatography; Continuous Particle Electrophoresis; A New Analytical and Preparative Capability; A Critical Evaluation of Gel Chromatography; A Comparison of Mobile-Phase Peak Dispersion in Gas and Liquid Chromatography; Ultra-High Pressure Gas Chromatography in Micro Columns to 2000 Atmospheres; Structural Effects and Properties of Oligomers of Interest in Separation; Indeterminate Errors in the Measurement of Chromatographic Peaks; Criteria of Identity and Purity in Chromatographic Separations; Non-linear Distribution Coefficient in Gas Chromatography; Effect of Carbon Number, Phase Polarity, Temperature, and Flow Rate on Preparative Scale Gas Chromatographic Separations of Saturated Methyl Esters; Support-Coated Open Tubular Columns, V. Columns with Various Liquid-Phase Loadings; Gas-Chromatographic Behavior of Pretreated Silica Gels; Introduction of Gas-Chromatographic Samples to a Mass Spectrometer; Observed Plate Height in TLC; Thin-Layer Chromatography of the N-Substituted Maleimides on Alumina; Stereochemical Factors; An Automated System for Sample Collection

and Computer Analysis of Thin-Layer Radio-Chromatograms; Quantitative Analysis by Liquid Chromatography; Adduct Formation with Metal Chelates Involved in Liquid-Liquid Extraction; and Studies in Solvent Sublimation Extraction of Methyl Orange and Rhodamine B. C. V. R.

### **Advances in Protein Chemistry** (Vol. 22).

Edited by Anfinsen, Anson, Richards, Edsall. (Academic Press, Inc., New York and London), 1967. Pp. xvi + 443. Price \$18.50.

Volume 22 of this well-known series contains the following articles: Covalent Labelling of Active Sites, by S. J. Singer; Milk Proteins, by H. A. McKenzie; Crystal Structure Studies of Amino Acids and Peptides, by Richard E. March and Jerry Donohue; and Crystal Structures of Metal Peptide Complexes, by Hans C. Freeman. C. V. R.

### **Infra-Red Spectroscopy in Surface Chemistry.**

By Michael I. Haur. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1967. Pp. xiii + 315. Price \$15.75.

The application of infra-red spectroscopy to surface studies is comparatively recent, but it has become a unique tool. This book is the author's own review of the experimental results obtained from this spectroscopic technique.

The increasing activity in surface chemistry together with the breakthroughs that have resulted have intensified the need for a comprehensive reference work. Atomic heterogeneity has largely been ignored by surface chemists other than those interested in catalysis because of the absence of a simple method of examination. The application of IR spectroscopy to surface studies has filled this gap. This book has been designed to acquaint all chemists with this method of identifying surface compounds. It is a valuable text for all scientists interested in catalysis, corrosion, ceramics, chromatography, polymer chemistry, biochemical interfaces, and related areas.

The contents of this volume are: Surface Chemistry; Infra-red Spectroscopy: Theory; The Application of Transmission Spectroscopy to Surface Studies; Experimental Considerations; Silica Surfaces; Acid Oxide Surfaces; Adsorption on Metals and Metal Oxides; Some

Miscellaneous Surfaces; Emission, Reflection, and Raman Spectra; and New Applications of Infra-red to Surface Studies. C. V. R.

Italian Physical Society—*Course 37. Theory of Magnetism in Transition Metals*. Edited by W. Marshall. (Academic Press, New York and London), 1967. Pp. x + 455. Price \$ 18.50.

This book contains the Proceedings of the International School of Physics "Enrico Fermi," Course XXXVII held at Varenna on Lake Como, Villa Monastero from 6th to 25th June 1966. The Course was directed by W. Marshall and it was attended by 71 members.

The contents of this volume are: W. Marshall—Introduction; W. M. Lomer—Band theory and magnetism; J. C. Phillips—Band theory of transition metals; P. W. Anderson and W. L. McMillan—Multiple-scattering theory and resonances in transition metals; J. L. Beeby—Theory of correlations in transition metals; H. Suhl—S-matrix theory of local moments; T. Moriya—Localized magnetic moments in transition metals and alloys; S. Doniach—Conduction-electron localized moment interaction in rare-earth metals and dilute alloys; J. Friedel—Ferromagnetic transitional alloys; S. Doniach—Dynamical properties and inelastic neutron scattering in magnetic metals; V. Jaccarino—Studies of the hyperfine interaction in transition metals; E. Daniel—Sur la polarisation de spin de electrons de conductibilite dans le fer et dans le nickel; A. Blandin—Virtual bound states or localized states in normal metals; and M. H. Cohen—Topics in the theory of magnetic metals. C. V. R.

Reports on Progress in Physics (Vol. XXX, Part I). Executive Editor A. C. Stickland. (The Institute of Physics and the Physical Society, 47, Belgrave Square, London. S.W. 1), 1967. Pp. 373. Price £ 5 15 sh. (£ 2 2 sh. to Members), including postage.

The *Reports on Progress in Physics* is under the general supervision of a special Editorial Board of the Publications Committee of the Institute of Physics and the Physical Society.

All Reports published in the Volume are also issued as individual articles.

The contents of this volume are: The measurement of the optical transfer functions of lenses, by K. Rosenhauer and K. J. Rosenbruch; Recent applications of semiconductor techniques in the study of nuclear

radiations, by E. M. Gunnersen; The Gunn effect, by P. N. Butcher; Chemico-physical processes in shock waves, by I. R. Hurlé; The theory of paramagnetic relaxation, by K. W. H. Stevens; Unitary symmetry, by J. M. Charap, R. B. Jones and P. G. Williams; Nuclear reactors as research instruments, by J. Walker; and Plasma stability in magnetic traps: I—Magnetohydrodynamic stability theory, by J. D. Jukes. C. V. R.

Engineering Kinematics. By Alvin Sloane. (Dover Publications, Inc., New York), 1966. Pp. x + 310. Price \$ 2.25.

This Dover edition, first published in 1966, is an unabridged and unaltered republication of the work first published by The MacMillan Company in 1941.

The contents of this book are: I. Introduction; II. The Rigid Body of Mechanics; III. Vectors; IV. Motion; V. Displacement; VI. Velocity; and VII. Acceleration. C. V. R.

Psychopharmacological Agents (Vol. 2). Edited by M. Gordon. (Academic Press, New York and London), 1967. Pp. xviii + 622. Price \$ 25.00.

This second volume is a convenient source book for the rapidly growing literature on the phenothiazines. It includes chapters on the butyrophenones, on miscellaneous psychopharmacological agents, and a chapter on the biochemical basis of mental disease which illustrates current research in the field. Nearly two hundred pages are devoted to extensive bibliographies on the phenothiazines and on meprobamate-like agents.

The titles of the chapters are: 1. Phenothiazines, by Maxwell Gordon; 2. Haloperidol and Related Butyrophenones, by Paul A. J. Janssen; 3. Biochemical Basis of Mental Disease, by Louise H. Greenberg, R. F. J. McCandless and Maxwell Gordon; and 4. Miscellaneous Psychotherapeutic Agents, by Maxwell Gordon. C. V. R.

Challenging Mathematical Problems (Vol. 2). By I. M. Yaglom and A. M. Yaglom. (Holden Day, Inc., 500, Sansome Street, San Francisco). 1967. Pp. 214. Price \$ 5.00 (paper); \$ 7.25 (cloth).

This is the second volume of the Russian problem book by the twin brothers Yagloms. The translation has been revised and adapted to suit the English-knowing readers. There are 74 problems in all which deal with

various branches of mathematics such as points and lines, lattices, topology, integers, non-decimal counting, polynomials, formulas for  $\pi$ , theory of primes, etc. The statements of the problems are given in the first section of about 42 pages. This is followed by the second section of about 150 pages which contains the complete solutions of the problems. A short third section of about 12 pages gives hints and answers to help the reader solve the problem himself before he needs to turn to section 2. Besides being "brainracks" for individuals, group or club efforts, these problems may also stimulate creative work.

A. S. G.

#### Non-linear Partial Differential Equations.

Edited by W. F. Ames. (Academic Press, Inc., Publishers, 111, Fifth Avenue, New York and London), Pp. 316. Price \$14 or 112 sh.

This is a collection of lectures delivered at the seminar organized by the University of Delaware, New York, during December 27-29, 1965. The seminar had for its objects review of current progress in the subject and presentation of latest research results. Nineteen active workers well known for their research contributions in diverse areas of application of non-linear partial differential equations have their expositions and results achieved recorded here. The volume is sure to be of value to mathematicians, physicists and engineers who are concerned with methods of solution of non-linear partial differential equations.

A. S. G.

**Titration in Non-Aqueous Solvents.** By Walter Huber. (Academic Press, Inc., Publishers, 111, Fifth Avenue, New York), 1967. Pp. 252. Price \$12.50.

This is the English version of the book first published in the German language in 1964 as Volume 1 in the series "Methods of Analysis in Chemistry".

The importance of non-aqueous titrations, particularly in organic analysis, is being increasingly realised, and the method is rapidly coming into vogue as an analytical technique of great accuracy. The book under review is a thorough practical aid on the subject providing instructions and working procedures for determination of special functional groups.

The book, in the main, is of two parts. Part I devoted to theory discusses in four chapters the general principles, methods of end-point detection, instruments employed, and

reagents. Part II devoted to practice contains special notes on acidimetric and alkalimetric determinations and analysis of mixtures of bases, and of acids. Also included are special fields like micro and ultramicro titrations, conductometric and high-frequency titrations, reactions of Lewis acids and Lewis bases, spectrophotometric determinations, etc. An appendix Part III gives pK values of compounds in a series of tables.

A. S. G.

**Introduction to Carbohydrate Chemistry.** By R. J. McIlroy. [Butterworth and Co. (Publishers) Ltd., 88, Kingsway, London W.C. 2], 1967. Pp. 133. Price 21 sh.

This small monograph contains the essentials of the chemistry of carbohydrates and can be used as a handy text-book on the subject by graduate students of chemistry, biochemistry, medicine or agriculture. The treatment, supplemented by a large number of structural formulae, is systematic and lucid. The first few chapters are devoted to general considerations as classification and configuration, synthesis and degradation, and the ring structure of sugars. Then there are chapters giving systematic treatment of monosaccharides, oligosaccharides, polysaccharides, and glycosides. Sections are also devoted to photosynthesis and biological oxidation.

A. S. G.

**Biochemical Polymorphisms in Animals.** (Institut National de la Recherche Agronomique, 149, Rue de Grenelle, Paris-7<sup>e</sup>). 1967. Pp. 544. Price 50 francs.

This volume contains the proceedings of the Tenth European Conference on Animal Blood Groups and Biochemical Polymorphisms held in Paris, 5-8 July 1966. It includes four general reports and more than eighty papers presented and discussed at the Conference.

The General Reports are as follows: Biochemical Polymorphisms in Animal Improvement by A. Robertson; Serological Properties of Red Cells and Their Use as Tools in General Immunology by R. R. A. Coombs; Principes et Applications de l'Immunochimie by P. Grabar; and Hemoglobin Types in Some Domestic Animals by T. H. J. Huisman.

The papers presented are grouped under the following heads, the figures in parenthesis show the number of papers: Blood Groups in Cattle (12); Blood Groups in Pigs (10); Blood Groups in Chicken, Turkey and Quail (13); Serum Protein Polymorphism in Cattle (7); Serum Protein Polymorphism in Sheep and

Canidae (5); Blood Groups and Serum Protein Polymorphism in Horse (4) and in Fish (4); Hemoglobins in Various Species (6); Milk Protein Polymorphism (4); Genetic Linkage Studies and Theoretical Studies (6); Serology, Chimærisms, Histocompatibility in Various Species (9); Antigenicity and Polymorphism in Sexual Gland Fluids (3).

The articles are mostly in English, and a few are in French and German. A. S. G.

**Farming in Hot Countries.** By Arthur Thomas. (Faber and Faber Ltd., 24, Russell Square, London), 1967. Pp. 180. Price 30 sh. net.

The author Dr. Thomas, a countryman descended from generations of farmers, describes in this book his own experience of farming and gardening in a place near equatorial Africa, and also gives first-hand information on farming based on his visits to a number of other countries in the tropics. A special feature of the publication is the thirty-two half-page photographs on crops and agriculture in the hot countries, especially relating to Uganda. The book is highly interesting and readable, and will be of special benefit to those people of cold countries who contemplate settling or taking temporary abode in hot countries.

A. S. G.

**Flowering Shrubs.** By B. P. Pal and S. Krishnamurthi. (Published by the Indian Council of Agricultural Research, Dr. Rajendra Prasad Road, Krishi Bhavan, New Delhi), 1968. Pp. 155. Price Rs. 20.00.

Shrubs give us some of the most colourful flowers, and any one interested in planning a garden in the compound of the house should consider the cultivation of suitable shrubs that will form a permanent feature of the house-cape. This attractive book, written by two experienced horticulturists, describes nearly a hundred flowering shrubs suitable for growing in Indian gardens. The book is illustrated with 40 plates, most of them in near natural colours. A concise description of each shrub is given, and the method of propagation is also briefly indicated.

The reviewer, looking at the figure and description of *Nyctanthes*, wanted to know if its common Indian name, other than 'tree of sadness', was the one he had in mind, but

neither the text nor the appendices could help him.

The book will be a welcome addition to the garden lover's bookshelf. A. S. G.

**Rats.** By S. V. Pingale, K. Krishnamurthy and T. Ramasivan. (Published by Food Grain Technologists' Research Association of India, Hapur, U.P., India), 1967. Pp. 91. Price Rs. 5.00.

This little booklet provides collected information on rats, their different types and distribution, the damage caused by them to food and crops, methods of control, and bibliography of published literature on the subject.

A. S. G.

#### Books Received

**Rats.** By S. V. Pingale, K. Krishnamurthy and T. Ramasivan. (Food Grains Technologists Research Association of India, Hapur, U.P.), 1967. Pp. 91. Price Rs. 5.00.

**Sonar in Fisheries—A Forward Look.** By D. G. Tucker. [Fishing News (Books) Ltd., 110, Fleet Street, London E.C. 4], 1967. Pp. 136. Price £ 1.17.6.

**Psychopharmacological Agents** (Vol. II). Edited by M. Gordon. (Academic Press, New York), 1967. Pp. xvii + 622. Price \$ 25.00.

**Titrations in Non-Aqueous Solvents.** By W. Huber. (Academic Press, Inc., 111, Fifth Avenue, New York), 1967. Pp. ix + 252. Price \$ 12.50.

**Advances in Astronomy and Astrophysics** (Vol. 5). Edited by Z. Kopal. (Academic Press, New York), 1967. xi + 355. Price \$ 50.55.

**The Mango—A Hand-Book.** (The Indian Council of Agricultural Research, New Delhi), 1967. Pp. 210. Price Rs. 11.50.

#### ERRATA

*Current Science*, 1968, Vol. 37, p. 61.

Column 2, line 15 below Table I

For  $1960\text{ cm}^{-1}$  Read  $1650\text{ cm}^{-1}$

*Current Science* 1968, Vol. 37, p. 95.

Column 1, in the Structure,

For  $-\text{OCH}_2$  Read  $-\text{OCH}_3$ .

Column 2, sixth line should be the first line.

## TOWARDS EVOLVING A TRISOMIC SERIES IN JUTE

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THE utility of aneuploid analysis in applied plant breeding and fundamental genetic work is well recognised. The contribution of Sears<sup>1</sup> in establishing the breadwheat monosomics is an outstanding example of the value of aneuploids, not only for the precise elucidation of the genetic architecture of the wheat plant but also for evolving superior plant types, through the systematic incorporation of desired chromosomes. Thus, the Chinese Spring wheat monosomics are now used the world over by wheat breeders for the location and transfer of rust-resistance genes in their otherwise superior varieties. In a diploid such as jute (*Corchorus olitorius* and *C. capsularis*:  $2n = 14$ ), since it cannot tolerate loss of whole chromosomes, the addition lines provided by trisomics would be of great value, both for fundamental genetic and applied breeding work. This is of particular significance in a crop like jute where further advance in breeding is now seriously hampered by a lack of adequate genetic data.

The first report of a trisomic jute plant was by Nandi<sup>2</sup> who recorded its spontaneous occurrence in *C. capsularis*. No further report is available until that of Swaminathan and Iyer<sup>3</sup> who isolated two trisomic individuals from the  $F_2$  generation of the cross *C. olitorius* × *C. capsularis*, where the male parent used was grafted on *C. olitorius*. Subsequently, a larger number of trisomics were recorded in the  $F_2$  of the second such hybrid obtained by them using grafted *C. olitorius* as female parent and irradiated pollen of *C. capsularis*. These trisomics as well as others obtained from diploid × autotetraploid crosses and from irradiated populations and their subsequent progenies have been carefully maintained and screened year after year, and subjected to detailed cytological and genetic analyses. The results of this study, obtained so far, are summarised in this paper.

**Sources of Occurrence.**—The trisomic population built up in jute arose from the following sources: (i)  $F_2$  and subsequent progenies of the interspecific cross, *C. olitorius* × *C. capsularis* made by Swaminathan et al.<sup>4</sup> and the backcrosses of these trisomics with the two parents, and of crosses between them-

selves, (ii) progenies of diploid × autotetraploid and subsequently triploid × diploid crosses in *C. olitorius*, and (iii)  $M_2$  and subsequent generations of fast-neutron and gamma-irradiated *C. olitorius* and *C. capsularis* varieties.

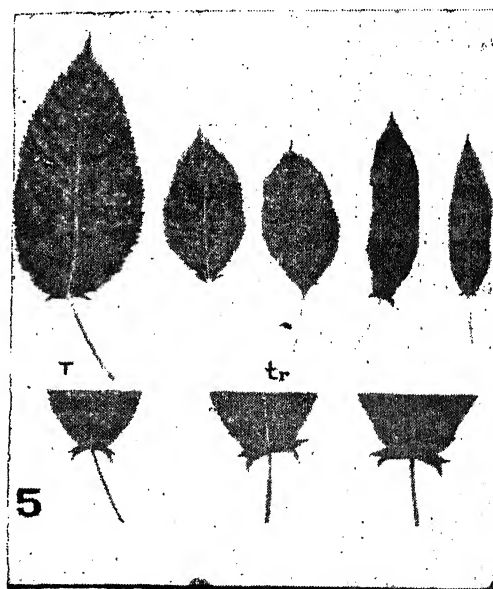
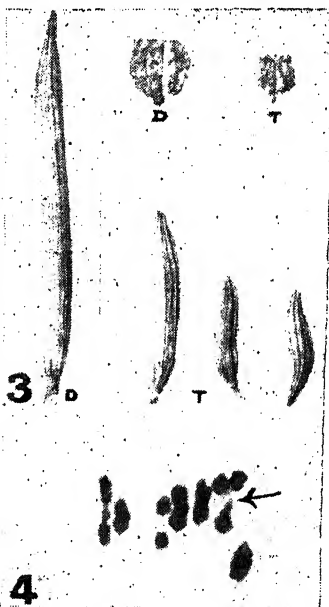
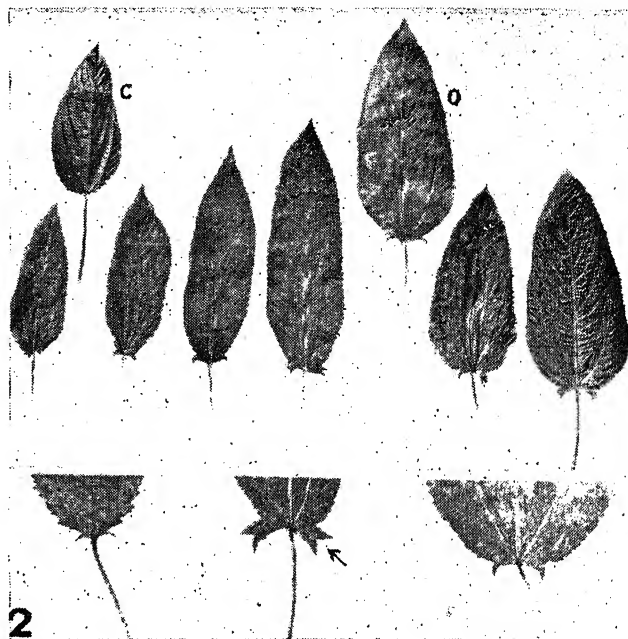
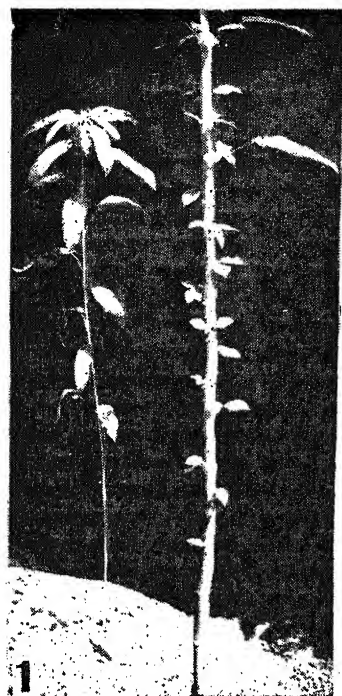
The varieties of *C. olitorius* used in this study were, C.G., JRO 632, JRO 620 and KT-1, and of *C. capsularis* were, JRC 321, JRC 412 and JRC 212. The standard method adopted for screening trisomics was the location of the suspected trisomic individuals at the time of thinning the crop (3-4 weeks after sowing), labelling them and subsequently confirming as many as possible by cytological examination of the microsporocytes at meiosis, and then collecting single-plant seeds after bagging. Since many of these plants had poor seed-set, they were sown in pans and the seedlings after identification were transplanted either to pots or in the field. Since mortality was generally higher under field conditions, particularly following heavy rains, a very large population had to be transplanted to pots, from the field.

### DIAGNOSTIC FEATURES OF TRISOMICS

**Seedling Characters.**—At the time of thinning, the jute plants are about 3-6 inches tall with 3 to 5 leaves. The trisomic plants could easily be spotted out by the characteristic glossiness of the adaxial leaf surface and a slight dorsiventral curvature of the lamina. In most cases, the leaves were oblong-ovate but the extra shine of the upper surface was the chief marker at this stage.

**Adult Plant Characters.**—As the plants grew taller, the trisomics were initially slow-growing, unbranched, generally weaker than the corresponding diploid sister-plants (Fig. 1). The most interesting feature was in the doubled nature of the filiform appendages at the base of the leaf-margin, which in the normal diploids was single on either side. Instead of one marginal tooth on each side being extended, the two last pairs of teeth became extended to varying lengths, thus furnishing a very distinctive marker phenotype (Fig. 2). In addition, there was segregation for intensity of anthocyanin pigmentation in different trisomic lines.





FIGS. 1-5. Fig. 1. A trisomic  $F_2$  (left) from the cross *Corchorus olitorius*  $\times$  *C. capsularis*, at the onset of flowering, with the more vigorous diploid segregant alongside. Fig. 2. Leaves from six different types of trisomic hybrids ( $F_2$ ), compared with those of the two parents, *C. capsularis* (c) and *C. olitorius* (o); note the prominent double nature of the filiform appendages (arrow). Fig. 3. Fruits of the diploid (D) parents with their corresponding trisomics (T), showing the characteristic stunting; the sub-globose capsules are those of *capsularis*. Fig. 4. Metaphase plate from meiosis I of microsporocytes, showing a distinct trivalent (arrow), and six bivalents, taken from the original slide of  $F_1$  meiosis prepared in 1960, proving the trisomic nature of the interspecific hybrid. Fig. 5. Leaves from four different trisomic plants (tr) derived from the diploid  $\times$  autotetraploid crosses in *C. olitorius*, compared with that of the tetraploid parent (T); note the large double appendages (enlarged below).



**Flower and Fruit Characters.**—The trisomics were early to flower but produced fewer flowers since those formed first usually dropped off. Stamens were fewer in number than in the normal diploid *C. olitorius*, and pollen fertility ranged between 50–70%. Meiosis in microsporocytes revealed the occurrence of either 7 bivalents and a univalent or 6 bivalents and a trivalent, thus providing two groups of trisomics. The most distinctive feature of trisomics in jute was the stunting of the capsules in both *C. olitorius* and *C. capsularis* (Fig. 3). In fact, the former group of trisomics was quite reminiscent of the short-capsuled  $F_1$  plant isolated by Swaminathan *et al.*,<sup>4</sup> from the *olitorius* × *capsularis* cross. The close resemblance in fruit-shape, leaf type, plant habit and even meiotic behaviour prompts this author to believe that the  $F_1$  hybrids obtained by us earlier were most probably trisomics by themselves. A re-examination of the original slides of  $F_1$  meiosis did show a few cells with 6 bivalents plus 1 trivalent clearly (Fig. 4).

Our earlier observation<sup>3</sup> of the occurrence of capsules in bunches in the first two trisomics isolated by us, and the suggested possibility of the extra chromosome being from the *capsularis* genome, did not find support in the subsequent generation of these trisomics. Hence, bunching of capsules cannot be considered as a stable marker, nor as any influence of *capsularis* chromosome.

It is interesting to recall that these two trisomics obtained from the  $F_2$  progeny of the first hybrid between *C. olitorius* var. C.G. × *C. capsularis* var. JRC-13 (grafted on the former) proved inviable in  $F_4$  and subsequent generations, whereas the 15 trisomics isolated from the  $F_2$  of the second hybrid between grafted *C. olitorius* var. JRO-620 × *C. capsularis* var. JRC-412 (2,000r X-rayed pollen) have proved more viable and a very large population of trisomics has now been built up from this material at I.A.R.I. The trisomics from the latter source have been back-crossed to the two parental species and a whole gamut of recombinant trisomics have resulted from this. An interesting observation is the recovery of a greater percentage of trisomic individuals in the progeny of the cross between a trisomic and *C. capsularis* than that with *C. olitorius* although the seed-set was much higher in the latter cross.

A new set of trisomics is now in the assembly line following crosses between diploid *vs.* autotetraploid and triploid *vs.* diploid *C. oli-*

*torius* vars. JRO-620 and JRO-632. The leaf-shape in these trisomics is a distinct departure from the earlier set of hybrid trisomics, in being more thick, ovoid, with larger dentations and showing the characteristic larger double appendages (Fig. 5). The third series of trisomics obtained in fast-neutron (2Kr) and gamma-ray (20 to 50 Kr) treated progenies, again constituted a class of their own. There were vigorous types with profuse branching habit and with typical stunted fruits, and at the other extreme were the drastic mutants with poor seed-setting but with miniature fruits. Two plants of *C. capsularis* with miniature fruits have also been isolated from gamma-irradiated  $M_2$  and  $M_3$  progenies. One interesting mutant of *C. olitorius* var. KT-1 in the fast-neutron-treated material, which proved to be a trisomic, showed hastate leaves (nearly tri-palmate) which is a rare shape for jute, but this mutant could not be recovered in subsequent generations owing to heavy seedling mortality.

Thus, in our present collection of over 1,000 lines of trisomic jute, now under intensive cytogenetic analysis we have been able to recognise at least five distinct phenotypic groups. These have been classified on the basis of habit and vigour, leaf-shape, size and texture, and the nature of filiform appendages, pigmentation (whether fully green, light red or only stipules red), meiotic behaviour and fruit characters. While the detailed analysis of each type is being published elsewhere, suffice it to say here that it is hoped that within the next year or two, a whole set of primary trisomics for the seven linkage groups of jute (*C. olitorius*) would become available for use in genetic analysis and for possible utilisation in building up chromosome addition lines in this important bast-fibre crop.

I am deeply indebted to Dr. M. S. Swaminathan, Director, I.A.R.I., for initiating me into this problem and for providing guidance and useful suggestions, and to Dr. H. K. Jain, Head of the Division of Genetics, for his interest in this work. To the many colleagues and students who collaborated with me in this venture at different times, I owe sincere gratitude and the details of their contributions would appear elsewhere in due course.

1. Sears, E. R., *Res. Full. Mo. Agric. Exp. Sta.*, 1954, 572, 58.
2. Nandi, H. K., *Nature*, 1937, 140, 973.
3. Swaminathan, M. S. and Iyer, R. D., *Ibid.*, 1961, 192, 893.
4. —, — and Sulbha, K., *Curr. Sci.*, 1961, 30, 67.

large positive shears persist in this layer for the longest duration.

9. Over Nagpur, the winter type of thermal gradient begins to appear in the lower troposphere towards the end of September and extends upwards to 200 mb. level by about the second week of October which is approximately the normal date of withdrawal of monsoon from this area.

10. At Trivandrum, the thermal gradient characteristic of the monsoon circulation begins to weaken by the end of September. By about the middle of November, the winter type of thermal gradients begin to appear in the upper troposphere and become increasingly prominent by the beginning of January. The normal date of withdrawal of monsoon rains from Trivandrum is about the beginning of December. However, it is more difficult to fix this date for Trivandrum than for Nagpur and New Delhi.

11. The main conclusions from the present study are the following:

(i) The onset of the monsoon rains at each of the three stations takes place when the meridional thermal gradients have reversed at all tropospheric levels between 200 and 700 mb.

(ii) The reversal starts in the upper troposphere about six weeks before the onset of the monsoon rains and progresses downwards, reaching 600 mb. level at about the time of onset of the monsoon rains.

(iii) The reversal of thermal gradient in the layer between 700 and 500 mb. takes place last and is almost simultaneous with the onset of the monsoon rains.

(iv) The pattern of thermal changes associated with summer-winter transition at Delhi has a broad similarity with the winter-summer transition. The similarity is less at Nagpur, while at Trivandrum there are substantial differences.

1. Sutcliffe, R. C. and Bannon, J. K., *Sci. Proc. Int. As. Met. IUGG, Rome*, 1954, p. 322.
2. Staff Members, Academia Sinica, *Tellus*, 1958, 10, 58.
3. Yeh Tu-Cheng, Dao Shih-Yen and Li Mei-Ts'un, *The Atmosphere and the Sea in Motion* (Rossby Memorial Volume), Oxford University Press, 1959, p. 249.
4. Ananthakrishnan, R. and Krishnan, A., *Curr. Sci.*, 1962, 31, 133.
5. — and Ramakrishnan, A. R., *Proc. W.I.O./UNESCO Symp., Met. Results of IIOF*, Bombay, 1965, p. 415.

## THE EPARCHÆAN UNCONFORMITY AND THE ARCHÆAN-PURANA BOUNDARY

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THE eparchæan interval in Indian geology is defined as the gap between the Puranas and the Archæans. The Archæans are defined as those rock formations which occur below the eparchæan unconformity. Does the eparchæan unconformity become evident by recognising Archæan and Purana formations or are the Archæans and Puranas recognised by identifying the eparchæan unconformity? These are questions for which we do not have definite answers.

The vast area of Peninsular India is by and large made up of Precambrian rocks. In these Precambrian provinces we do not have any definite demarcation between the Archæan and Purana rocks. Unlike the breaks that occur higher up in the geological time scale, the eparchæan break does not have the strong support that faunal evidence affords and we are obliged to depend entirely on geological evidence.

The main problem of these two groups of rocks is in their distinction. What are the diagnostic characters of the Archæans and Puranas and what differences are there in these characters which allow us to distinguish them? The answer is indefinite and vague. We do not have any really diagnostic characters. However, metamorphic grade and intensity of diastrophism have served as a basis for the distinction of these two groups of ancient rocks. The result of this is that almost everything that is metamorphosed has been placed under the Archæan group. A careful consideration of the problem clearly shows that the two criteria are really inadequate and can never be of such importance as to unfailingly serve as a basis of differentiation of these two groups of rocks.

In Indian geology since the creation of the Dharwar system every other system or series in a similar stratigraphic situation was referred

to as Dharwarian although the rocks have their own identity.

This kind of usage was very common in spite of some resentment (West, 1939; Pichamuthu, 1963). Krishnan writes "the term has become so well entrenched in geological nomenclature that it is scarcely possible to discard it" (1956, p. 100).

If we consider the Precambrian provinces of peninsular India it becomes quite apparent that the major groups of rocks which are metamorphosed and structurally very much disturbed are included within the Archæan group, and the succeeding series or systems of rocks which are laid over the earlier with a clear cut erosion unconformity have been placed in the Purana group. In a general way the Puranas are less metamorphosed and less disturbed. (The Delhi system is however an exception). This uncertain basis of classification of rocks into the Archæan and Purana groups results in a number of problems. Certain groups of rocks like the Pakhals, Transition rocks in the Son Valley, Bijawars

Precambrian geology. It must however be mentioned that these isotope ages have their own limitations and cannot be entirely relied upon. What have so far been considered as Archæans, range in age from 3000 m.y. to 900 m.y. The Cuddapahs have been thought to be the ideal representatives of the Purana group. The basic rocks in the lower Cuddapahs along the western margin of the Cuddapah basin have given (K-Ar ages) 1160 m.y. (Aswathanarayana, 1964).

These ages are probably much higher than what one would expect for the Cuddapahs, and are well within the range of the Archæans. The Delhi system of Rajasthan which is considered by Heron as the equivalent of the Cuddapahs dates 735 m.y. to 800 m.y. We can no longer consider the Delhis as the time equivalents of the Cuddapahs. The isotope age data also prove that all Archæan rocks are not the equivalents of Dharwars. It would be useful to tabulate these rocks in their geochronological order and see what we can gather from it.

TABLE I

1. Vindhya	..	1160 m.y. (?)	1. Mathur, 1964, Vinogradov <i>et al.</i> , 1964
2. Sausar-Satpura Gaya-Ranchi-Muri-Aravalli (?)	..	950 "	(Aravalli = 1500 m.y. Vinogradov <i>et al.</i> , 1964)
3. Sakoli	..	1335 "	2. Sarkar <i>et al.</i> , 1964
4. Amgaon	..	1434 "	3. do.
		1630 "	4. do.
5. Eastern Ghats	..	1600 "	5. Aswathanarayana, 1964
6 a. Iron Ore Orogeny }	..	2000 "	6a. Sarkar <i>et al.</i> , 1964
6 b. Upper Dharwar }	..	2600 "	6b. Aswathanarayana, 1967
7. Middle Dharwar	..	2900 "	7. do.
8. Lower Dharwar	..	>3000 "	8. do.
9. Older metamorphics	..		9. Sarkar <i>et al.</i> , 1964

and many others are examples whose position is doubtful. The fact that any one of these groups of rocks rest over Archæan rocks with an unconformity does not afford ground to place them in the Puranas, for in the Archæans themselves we can have two or more major groups of rocks. In South India we have the Dharwar and Eastern Ghat rocks both belonging to the Archæan group.

We may summarise our understanding that till recently we believed that all Archæans are Dharwars which are followed by the eparchæan unconformity which in its turn is followed by the Purana group of rocks.

In the last two decades isotope ages of rocks have started appearing in Indian geology and this has completely changed our ideas of

The dates given in Table I are those of the orogenies except in the case of the Cuddapahs and Vindhya where they are the ages of sedimentation.

From Table I it seems that orogeny is repeating itself rhythmically. There does not seem to exist any common time gap for all regions which can be likened to that of the eparchæan interval. Further it also touches upon the controversial point whether orogeny and epeirogeny are episodic or continuous. From the spread of events recorded in Table I it appears more likely that orogeny is perhaps continuous. This continuous character is possibly obscured by the fact that this hypothesis is being examined on a limited scale.

The base of the Cambrian is estimated at around 600 m.y. The pre-Cambrian is naturally anything over 600 m.y. The division of this long span of time (> 3000-600 m.y.) into Archæas and Proterozoic is convenient and necessary. If so where should we draw the demarcation line? If we agree that orogeny and epeirogeny are continuous then the demarcation line is arbitrary and we can perhaps adopt a scheme like the one given below where the divisions are more or less equal and also mark the end of some important orogenies in India.

Cambrian		600 m.y.
Upper		
Purana =		1,000 m.y.
Proterozoic		
Lower		1,600 m.y.
Upper		2,000 m.y.
Archæan		
Lower		

If on the other hand we accept the premise that orogeny is episodic we can adopt the geochronological divisions arrived at by Voitkevich\* on the basis of isotope ages from the Baltic, Ukrainian and from the African, Indian and Australian shields. The boundaries are at  $2650 \pm 150$  m.y.;  $1800 \pm 90$  m.y.;  $1030 \pm 50$ ;  $550 \pm 10$  m.y. Stockwell\* finds good support for the above divisions from the Canadian shield ages. Vinogradov and Tugarinov\* propose > 2700 m.y.  $\pm 150$ , Kata Archæan;  $1900 \pm 100$  m.y. to  $2700 \pm 150$  m.y. Archæan;  $1100 \pm 100$  m.y. to  $1900 \pm 100$  m.y. Lower proterozoic;  $600 \pm 50$  m.y. to  $1100 \pm 100$  m.y. Upper proterozoic. These divisions are

not much different from what Voitkevich proposed and any one of them should be quite adequate.

Stockwell (1964) following the 'American commission on Stratigraphic Nomenclature' pleads that the actual rock of a type area be used as the basis of a definition of a unit rather than isotope dates. He illustrates this by discussing the Precambrian structural provinces of Canada. It must be confessed that it is rather very doubtful whether such a scheme can be useful in building up the geochronological divisions in India.

The present need is the recognition of the subdivisions of the pre-Cambrian period and it does not very much matter which scheme is adopted. The subdivision of the pre-Cambrian period will enable us more precisely to state the horizon of the Archæan formations. The fallacy of equating an unknown with another unknown could thus be easily avoided.

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\* These references are drawn from Prof. J. Sutton's paper in *Nature*, 1963.

1. Aswathanarayana, U., *Brochure, XVII Intern. Geol. Congr.*, New Delhi, 1964.
2. Krishnan, M. S., *Geology of India and Burma*, 1956.
3. Mathur, S. M., *Ind. Minls.*, 1964, **18**, 2, 158.
4. Pichamuthu, C. S., *Jour. Geol. Soc. Ind.*, 1963, **4**, 79.
5. Sarkar, S. N., Polkanov, A. A., Gerling E. K. and Chukrov, F. V., *Sci. & Cult.*, 1964, **30**, 527.
6. Stockwell, C. H., In *Geochronology of Canada*, 1964, p. 52.
7. Sutton, J., *Nature*, 1963, **198**, 731.
8. Vinogradov, A. and Tugarinov, A., *XVII Intern. Geol. Congr.*, New Delhi, 1964 (In press).
9. West, W. D., *Curr. Sci.*, 1939, **3**, 138.

## MYCOFLORA OF THE ROOT REGION\*

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THE root region comprises the most active zone of microhabitats in the heterogeneous soil structure. Some generalizations regarding the numerical and physical stimulation of micro-organisms in the root region have been feasible<sup>1</sup>; but little information is available on the initiation of rhizosphere effect on soil fungi, nor has qualitative studies on rhizo-

sphere fungi been possible on account of limitations in techniques. The need for newer and improved techniques has been repeatedly emphasized.<sup>1-3</sup> Apart from the tedium of examining the slides, the difficulty of identifying the fungi present limit the usefulness of the direct observation techniques<sup>4-10</sup>; it is pointed out that the micro-environment itself gets perceptibly altered,<sup>11-12</sup> *in situ* studies employing these methods. In the case of isolation methods<sup>8-13-15</sup> aside from other limitations it

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is impossible, without further evidence, to tell which fungi on a culture plate may have arisen from hyphæ, and it is believed that fungi are present mainly as mycelium in the rhizosphere.<sup>8,16</sup> Also, it remains to be demonstrated whether certain species of non-pathogenic fungi make the rhizosphere their main locus of activity.

The operations used in taking, preparing and diluting the soil samples determine to a great extent the final picture; the estimates can very easily be affected by slight changes in techniques and by method-medium interactions. The progress has been hindered due to lack of adequate techniques that would facilitate evaluation and isolation of fungi present in the root region in an active mycelial state without basically altering its environment. An agar slide technique for direct observation of fungi occurring on root-surface has been tested in this laboratory. Minimum nutrient agar medium is provided on a glass slide for initiation of growth of fungi present on the roots and inducing of spore formation by them for ready and rapid scrutiny under stereo and light microscopes.<sup>17</sup> Observations on root-surface fungi of *Gossypium arboreum* L.—strain K6 grown on Coimbatore cotton soil, and the scope of this technique are discussed here.

The method is simple and inexpensive. Five centimeter pieces of roots freed from adhering soil particles and surface-dried on sterile filter-paper, were placed on thin layer of Martin's agar with rose bengal and streptomycin on glass slides. In case of plants raised on clayey soils, it was also necessary to wash the roots with a fine jet of sterile water to remove adhering soil particles and remove the moisture with sterile filter-paper prior to plating to cut down the bacterial development to a negligible level. Slides were incubated in sterile, moist, Petri plates for 30–36 hr. at 25° C. The slides were examined unstained, or stained after air-drying and fixing. Mycelia and sporophores with spores were observed growing on the agar smear and on to the glass surface, as well as on the upper surfaces of the root pieces. Identification is facilitated as it is possible to observe on the slides the pattern of attachment of spores to sporophores. Where necessary, fungi could be conveniently isolated for species identification and confirmation. The root pieces were seldom found overcrowded; invariably pure clusters of individual forms occurred. Also, there were regions where no fungus appeared. Incidentally, it was found that if the root was plated before the agar

medium set thereby getting coated with agar, sterile mycelia of a phycomycete (unidentified) predominated to the exclusion of most other fungi. With longer incubations, only *Mucor* spp. and *Rhizopus* spp. emerged through the dense covering of the hyaline hyphæ in such samples. In slides, where root pieces were plated without thoroughly removing the moisture following washing, the surface of agar along the length of the root was overridden with bacteria, but from the upper surfaces of the root grew pure colonies of several fungi, but with shorter sporophores.

*Fusarium solani* (Mart.) App. et Wr. and an unidentified phycomycete, and occasionally *Rhizopus oryzae* were observed on root-tips including the root-cap (Fig. 1) of cotton seedling roots. Four genera of fungi, viz., *Alternaria*, *Aspergillus*, *Cunninghamella* and *Fusarium*, have also been recorded at root-tip regions of *Crotalaria juncea* L. using this technique.<sup>17</sup> These observations are of significance in revealing initiation of rhizosphere effect as the root strikes the soil. As the roots mature, the mycoflora becomes stabilized. The rhizosphere effects of root-tip regions have to be viewed against two facts: root exudation at this region is particularly important<sup>18,19</sup>; secondly, the root-tip is continuously getting in contact with fresh soil. Previously, investigators<sup>20,21</sup> failed to observe any fungus at root-tips of various plants. In fact, Parkinson,<sup>1</sup> concludes 'that the root-tip region of the actively growing root remains uncolonized during the whole period of active growth'.

*Fusarium solani* and the unidentified phycomycete were observed on cotton roots throughout the period of observation of 60 days from the date of sowing. As the root system grew, *F. solani* became progressively dominant and the phycomycete less frequent. After 45 days, *F. solani* was the most dominant fungus on the root system. The other fungi observed were *Aspergillus flavus* Link., *A. luchuensis* Inui., *A. nidulans* (Eidam.) Winter, *Chaetomium olivaceum* Cook and Ellis., *Choanephora* sp., *Cladosporium epiphyllum* Persoon, *Mucor hiemalis* Wehmer., *Penicillium* spp., *Rhizopus oryzae* Went and Gerlings and *Trichoderma viride* Pers. ex Fries. The frequency of occurrence of these fungi was less on the roots of 60-day-old plants.

It is difficult to say at this stage whether some fungi are suppressed and what the forms are. It also restricts its use to the study of root-surface fungi, and those that invade the root-tissues. It provides scope for development

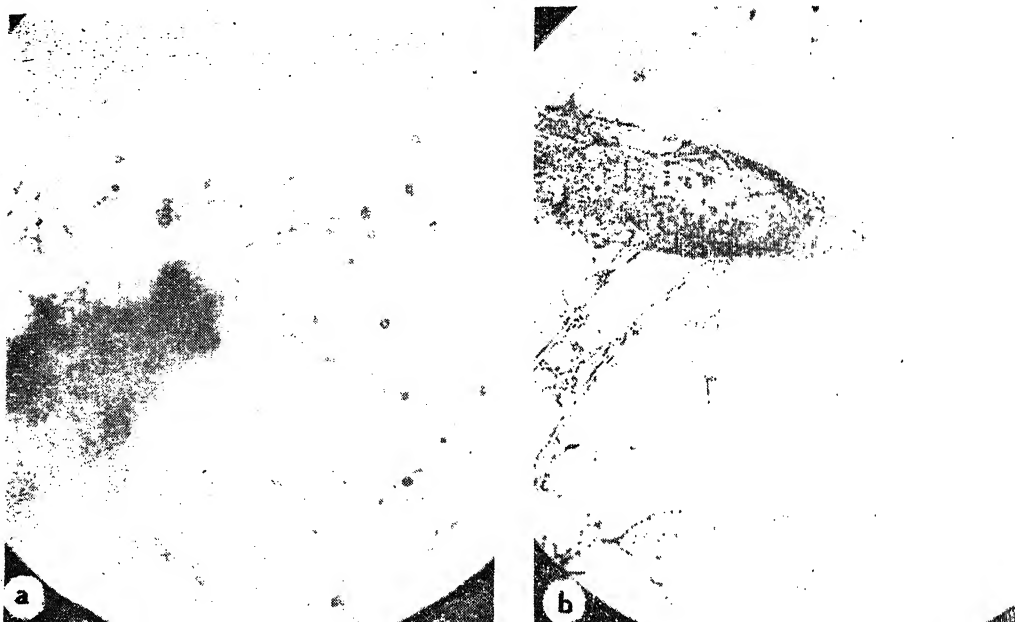


FIG. 1. *a*, *Fusarium solani* and *b*, An unidentified phycomycete growing from root-tips of cotton—K 6 seedling,  $\times 360$ .

of fungi without exerting much selectivity between heavily- and sparsely-sporulating forms. It affords opportunity for the mycelia to grow and produce spores at the same time avoiding chances of spores lodged on roots from germinating and growing through the vegetative phase to produce reproductive structures in the limited period of incubation. Several genera of fungi, not normally found in dilution plates in parallel studies, were observed on the roots by this technique.<sup>17</sup> For screening fungi that invade the root-tissues, the seedling roots were surface-sterilized with 1 in 14 aqueous calcium hypochlorite solution; such samples required incubation for longer than 36 hr. The results were significant in revealing the presence of species of *Aspergillus*, *Choanephora*, *Cladosporium* and *Fusarium* inside the tissues of healthy cotton roots. However, there appears to be some residual inhibitory effect of the surface-sterilizing agent, which needs to be elucidated.

It has been found that this technique could be adapted to suit specific requirements with judicious choices of medium, pre-treatment of root samples, and standardization of incubation time and temperature.

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1. Parkinson, D., In *Soil Biology*, Academic Press, New York, 1967, p. 449.
2. Menzies, J. D., *A. Rev. Phytopathology*, 1963, **1**, 127.
3. Warcup, J. H., In *Soil Biology*, Academic Press, New York 1967, p. 51.
4. Cholodny, N. G., *Arch. Mikrobiol.*, 1930, **1**, 620.
5. Jensen, H. L., *Proc. Linn. Soc.*, N.S.W., 1936, **55**, 145.
6. Rossi, G., Riccardo, S., Gesuè, G., Stanganelli, M. and Wang, T. K., *Soil Sci.*, 1936, **41**, 53.
7. Jones, P. C. T. and Mollison, J. E., *J. gen. Microbiol.*, 1948, **2**, 54.
8. Parkinson, D., *Pedologie*, 1957, **7**, 145.
9. Brown, J. C., *Trans. Brit. mycol. Soc.*, 1958, **41**, 81.
10. Chesters, C. G. C. and Parkinson, D., *Pl. Soil*, 1959, **11**, 145.
11. Dobbs, C. G. and Henson, W. H., *Nature, London*, 1953, **172**, 197.
12. Sewell, G. W. F., *Trans. Brit. mycol. Soc.*, 1959, **42**, 312.
13. Warcup, J. H., *Nature, London*, 1950, **168**, 117.
14. Harley, J. L. and Waid, J. S., *Pl. Soil*, 1955, **7**, 96.
15. Stover, R. H. and Waite, B. H., *Phytopathology*, 1953, **43**, 700.
16. Agnihotrudu, V., *Naturwissenschaften*, 1955, **42**, 515.
17. Sivasithamparam, K. and Sulochana, C. B., *Pl. Soil*, 1968 (In press).
18. Pearson, R. and Parkinson, D., *Ibid.*, 1961, **13**, 391.
19. Schroth, M. V. and Snyder, W. C., *Phytopathology*, 1961, **51**, 389.
20. Rovira, A. D., *J. appl. Bacteriol.*, 1956, **19**, 72.
21. Parkinson, D., In *Plant Microbe Relationships*, Publishing House, Czechoslovakia Akad. Sci., Prague, 1965, p. 69.

## LETTERS TO THE EDITOR

### A UNIVERSE FILLED WITH BLACK-BODY RADIATION

As pointed out by Gamow many years ago, in the early evolutionary period of the universe (i.e., almost immediately after the 'big bang'), radiation energy must dominate over material energy as  $t \rightarrow 0$ . Again as the densities become very high it is reasonable to assume very high temperatures. Under these circumstances the equation  $\rho - 3p = 0$  can be taken as the equation of state of the smoothed out contents of the universe.

Taking the geometry of the universe to be described by a line-element of the form

$$ds^2 = -e^\lambda dr^2 - r^2(d\theta^2 + \sin^2\theta d\phi^2) + e^\nu dt^2$$

one can set up the problem of finding  $\lambda$  and  $\nu$  as functions of  $(r, t)$  satisfying the following conditions: (i) the space-time is pervaded by a perfect fluid distribution with the stress-energy tensor given by  $T^{ik} = (p + \rho)V^i V^k - p g^{ik}$ ; (ii) the stream-lines are geodesics:  $V^i V_{;i} = 1$ ,  $V^i_{;k} V^k = 0$ ; (iii) there is no rotation:  $V_{i,k} - V_{k,i} = 0$ ; (iv) there exists an equation of state of the form  $f(\rho, p) = 0$ .

The general problem set up in this manner can be solved in explicit terms and one finds

$$\gamma(\rho) e^{-\nu} = e^{-\lambda} = 1 - \frac{1}{3} 8\pi r^2 \rho = \frac{A(\rho)}{r} \quad (1)$$

where  $\gamma(\rho)$  and  $A(\rho)$  are functions of  $\rho$  satisfying certain equations which can be integrated as soon as the equation of state  $f(\rho, p) = 0$  is explicitly given.

If the equation of state is  $\rho - 3p = 0$  one finds that  $A(\rho) = 0$ ,  $\gamma(\rho) = 0$ , so that the line-element becomes

$$ds^2 = -(1 - \frac{1}{3} 8\pi r^2 \rho)^{-1} (dr^2 - dt^2) - r^2(d\theta^2 + \sin^2\theta d\phi^2) \quad (2)$$

and that a particularly simple expression for  $\alpha = 1/3 \cdot 8\pi\rho$  as a function of  $r$  and  $t$  containing an arbitrary parameter  $k$  is given by

$$1 + \alpha r^2 = 2\sqrt{\alpha} [t - k(t^2 - r^2)] \quad (3)$$

$$1 - \alpha r^2 = 2\sqrt{\alpha} \sqrt{[(t^2 - r^2)(1 - kt)^2 - k^2 r^2]} \quad (4)$$

The stream-lines are given by

$$V^i V^j = r \sqrt{\alpha} (1 - 2kt). \quad (5)$$

The solution is not valid at  $r = 0$ ,  $t = 0$  because then  $\rho \rightarrow \infty$ . Again if  $r \rightarrow 0$ ,  $t \rightarrow 0$  with  $r = t$  then  $(1 - \alpha r^2) \rightarrow 0$  so that the line-

element exhibits a Schwarzschild-type singularity. As a matter of fact if one assumes the big bang to occur at  $r = 0$ ,  $t = 0$ , the shock-wave generated at this event travels onwards with the fundamental velocity carrying this singularity on its surface. This shock-wave reaches a sphere of radius  $r$  at the co-ordinate time  $t = r$ . The region of validity of the solution at any time  $t$  is the interior of the shock-wave front  $r = t$ .

The expression (5) for the velocity shows that for  $k = 0$  or  $k < 0$  the universe is expanding while if  $k > 0$  it has oscillatory character reaching a momentary stationary state at  $t = 1/2k$ . Though in this case the discussion of the shock-waves and of the region of validity of the solution is very much different the above description of the spreading of the debris after the big bang at  $r = 0$ ,  $t = 0$ , holds good for  $t < r < 1/2k$ .

It may be noted that the solution described here by equations (2)-(5) is metrically equivalent to Robertson-Walker line-element with  $\rho = 3p$ . But whereas the latter describes the big bang as seen by an observer moving with the debris, the present solution describes the after-effects of the event as seen by an observer located at the place of the event watching the debris flying around him.

The solution (1) of the problem, formulated here in the beginning, is more general and contains solutions metrically equivalent to Robertson-Walker line-element as particular cases.

Gujarat University, P. C. VADYA.  
Ahmedabad-9, January 4, 1968.

### NEAR ULTRAVIOLET ABSORPTION SPECTRUM OF 1-CHLORO- 9, 10-ANTHRAQUINONE VAPOURS

THE absorption spectrum of 1-chloro-, 9, 10-anthraquinone vapour was photographed with the help of a quartz-to-pyrex graded seal cell by a Zeiss Q-24 medium quartz spectrograph using xenon arc as the source of continuum. With the cell-length of 120 cm., two systems develop: one in the region 2733-3132 (System I) at a temperature of 90° C. and the other in the region 3651-3310 (System II) at a temperature of 150° C.

System I consists of about thirty bands which are very sharp, intense and degraded towards red. The strongest band at  $33324\text{ cm}^{-1}$  is identified as the (0,0) band, in agreement with the Frank-Condon principle, as this band develops at as low a temperature as  $70^\circ\text{C}$ . The system has been analysed in terms of excited state frequencies 234, 438, 621, 901 and  $1077\text{ cm}^{-1}$  and ground state frequencies 248, 461 and  $696\text{ cm}^{-1}$ . System II consists of ten bands which are broad, diffuse and weak in comparison to those in System I. The (0,0) band has been taken at  $27376\text{ cm}^{-1}$  which is the strongest in the system, and frequencies 235, 446 and  $918\text{ cm}^{-1}$  in the excited state are found to be superposed on this band. The vibrational analyses of the main bands of the two systems are given in Tables I and II.

It has been found during the present studies that 1-chloro substitution in the 9,10-anthraquinone ring brings forth changes in the ultraviolet spectra of the parent molecule<sup>1</sup> in two ways: (i) the (0,0) band of System I is shifted to red by  $956\text{ cm}^{-1}$  and of System II by  $151\text{ cm}^{-1}$  (ii) The order of intensity is interchanged, i.e., System I of 1-chloro 9,10-anthraquinone is more intense than System II. Assuming  $C_s$  to be the point symmetry for the molecule and taking correspondence to the absorption of 9, 10-anthraquinone,<sup>1</sup> both systems have been assigned to an allowed transition of the type  $\pi-\pi^*$  ( $^1A' \rightarrow ^1A'$ ). The correlation of the ground and excited state

TABLE I  
Analysis of System I

Wave number in $\text{cm}^{-1}$	Intensity	Separation from (0,0) band	Assignment
31119	0	-1405	0-696-461-248
32166	1	-1158	0-696-461
32384	1	-940	0-696-248
32868	2	-461	0-461
33076	5	-248	0-248
33324	10	0	0,0
33558	10	+234	0+234
33762	10	+438	0+438
33945	8	+621	0+621
34225	8	+901	0+901
34401	6	+1077	0+1077
34461	6	+1137	0+901+234
34676	3	+1342	0+901+438
34857	2	+1533	0+901+621
35077	2	+1753	0+901+621+234
35318	2	+1989	0+901+1077
35729	1	+2405	0+901+1074+438

TABLE II  
Analysis of System II

Wave number in $\text{cm}^{-1}$	Intensity	Separation from (0,0) band	Assignment
27376	10	0	(0,0)
27611	5	235	0+235
27822	5	446	0+446
28294	3	918	0+918
20536	3	1160	0+918+235
28761	2	1385	0+911+446
29223	2	1847	0+2×918
29466	2	2090	0+2×918+235
29670	1	2294	0+2×918+446
30112	1	2736	0+3×918

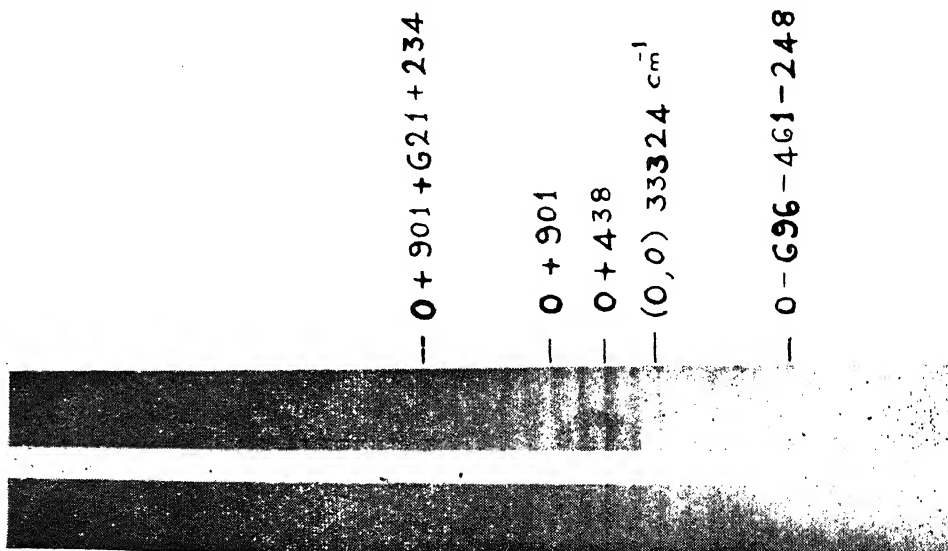


FIG. 1. Absorption spectrum of 1-chloro 9, 10-anthraquinone (System 1).



frequencies with their modes of vibrations are listed in Table III.

TABLE III

Correlation of ground and excited state frequencies for 1-chloro 9, 10-anthraquinone

Ground state frequency				Excited state frequency absorption	Mode of vibration
Raman <sup>2</sup>	Infrared <sup>2</sup>	Emission <sup>2</sup>	Absorption (present work)		
250	..	248	248	238	$\alpha'$ skeletal deformation
451	..	..	461	438	$\alpha'$ C—O bending
698	700	690	696	621?	$\alpha'$ ring breathing
950	942	..	..	918	$\alpha'$ skeletal deformation
1035	1031	1035	..	..	$\alpha'$ C—H bending
1670	1675	1697	..	1077	$\alpha'$ C—O stretching

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Varanasi-5, November 14, 1967.

1. Singh, S. Nath and Singh, R. S., *Ind. J. Pure and Appl. Phys.*, 1967, 5, 245.
2. — and —, *Curr. Sci.*, 1967, 36, 483.
3. — and —, *Indian Science Congress*, 1968.

# INFRA-RED ABSORPTION SPECTRA OF COPPER (II) COMPLEXES OF SOME $\alpha$ -HYDROXY-CARBOXYLIC ACIDS

INFRA-RED spectroscopy has been successfully applied to the study of transition metal complexes.<sup>2,3</sup> The present note reports the results of infra-red studies of copper (II) complexes of glycollic, lactic,  $\alpha$ -hydroxy-iso-butyric and mandelic acids in solid phase using KBr disc. The purpose of the investigation was to seek information on the nature of the bond between the metal ions and the ligands. In the present study the carboxylate stretching frequency has been used as a guide to the nature and extent of metal-oxygen bonding in the  $\alpha$ -hydroxy-carboxylate chelates.

The infra-red spectra of the copper (II) complexes of glycollic, lactic,  $\alpha$ -hydroxy-iso-butyric and mandelic acids are recorded in Fig. 1. Of the various possible vibrational modes only the carboxylate stretching frequencies have been tabulated in Table I.

These frequencies can be identified with certainty and are also most sensitive to changes in the strength of the metal-oxygen interaction.<sup>2</sup> The data in Table I show that the anti-symmetric band shifts to higher frequencies

and the symmetric band to lower frequencies as one proceeds from copper(II) glycolate to copper(II) mandalate through lactate and  $\alpha$ -hydroxy-butyrate. The frequency separation follows the order: mandalate >  $\alpha$ -hydroxy-iso-butyrate > lactate > glycolate.

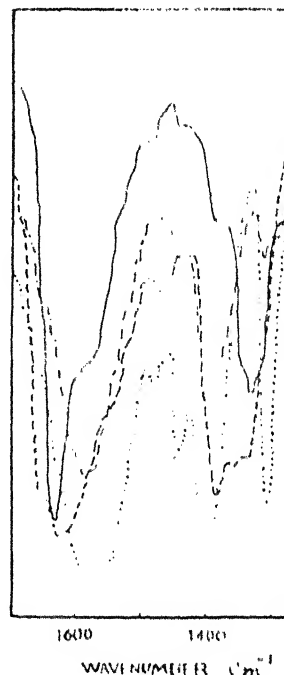


FIG. 1

— Mandalate, — — —  $\alpha$ -Hydroxy-iso-butyrate,  
--- Lactate, ..... Glycolate.

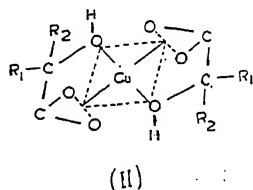
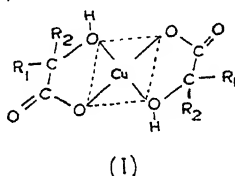
TABLE I

Antisymmetric and symmetric COO stretching frequencies and their separation in copper(II) complexes

Complex	Carboxylate stretching frequency (cm. <sup>-1</sup> )		
	Anti-symmetric	Symmetric	Separation
Cu (II) Glycolate ..	1570	1400	170
Cu (II) Lactate ..	1590	1400	190
Cu (II) $\alpha$ -Hydroxy-iso-butyrate ..	1625	1380	245
Cu (II) Mandalate ..	1640	1335	305

The anti-symmetric carboxylate stretching frequencies of the metal chelates of some amino-acids have been interpreted in a variety of ways in recent years. Thus for example Sen *et al.*<sup>2</sup> and Saraceno *et al.*<sup>4</sup> claimed that the metal-oxygen bond in Cu(II), Ni(II), and Zn(II) glycimates are essentially ionic, since their frequencies are almost the same as that

of potassium glycinate and sodium acetate; on the other hand Rosenberg<sup>3</sup> and Nakamoto *et al.*<sup>2</sup> have concluded that the shift of the carboxylate band to higher frequencies in the order: Ni(II), < Cu(II) < Pt(II) is an indication of the increasing covalent character of the metal-oxygen bond. X-ray crystal structure of copper (II)-glycollate<sup>1</sup> suggests that it has a square planar structure similar to some copper (II)-amino-acid complexes. Following the work of Nakamoto *et al.*,<sup>2</sup> it is suggested that the copper(II) complexes of hydroxycarboxylic acids can have either of the two following structures



X-ray structure data indicates that symmetrical carboxylic groups (*i.e.*, formula II) exist in certain metal chelates such as  $M^{II}-(CH_3COO)_4 \cdot 2H_2O$ ; ( $M^{II} = Cr, Cu$ ).<sup>6</sup>

The results reported here support formula I, rather than formula II. In formula I, the covalent character of the metal-oxygen bond will lead to more asymmetric vibration of the carboxylate group and would result in an increased frequency separation of the two carboxylate bands as has been reported here. The progressive shift to higher frequencies of the antisymmetric band and the progressive increase in the frequency separation as one proceeds from glycollate to mandalate through lactate and  $\alpha$ -hydroxy-iso-butyrate is not compatible with the theory of symmetrical co-ordination of the carboxylate ion represented by formula II. If such were the case the anti-symmetric and symmetric stretching bands would be expected to shift in the same direction with an increase in the co-ordination bond strength.

Thanks are due to Shri Milap Chandra A. Mathur of the Department of Chemistry, Uni-

versity of Florida, Gainesville, U.S.A. for help in getting the infra-red spectra recorded.

Department of Physics,  
University of Rajasthan,  
Jaipur, January 5, 1968.

P. V. BAKORE.

1. Forrest, J. G., Prout, C. K., Rossotti, F. J. C., *Chem. Comm. (London)*, 1966, p. 628.
2. Nakamoto, K., Morimoto, Y. and Martell, A. E., *J. Amer. Chem. Soc.*, 1961, **83**, 4528.
3. Rosenberg, A., *Acta Chem. Scand.*, 1956, **10**, 840.
4. Saracen, A. J., Nagawaka, I., Mizushima, S., Curran, C. and Quagliano, J. V., *J. Amer. Chem. Soc.*, 1958, **80**, 5018.
5. Sen, D. N., Mizushima, S., Curran, C. and Quagliano, J. V., *Ibid.*, 1955, **77**, 211, 5508.
6. Van Niekerk, J. N. and Schoening, F. R. I., *Acta Cryst.*, 1953, **6**, 277, 501.

#### PAPER CHROMATOGRAPHIC METHOD FOR THE SEPARATION AND IDENTIFICATION OF TITANIUM, URANIUM, THORIUM AND ZIRCONIUM AS THEIR THIOCYANATE COMPLEXES

IN the previous communications<sup>1-3</sup> from this laboratory separation and identification of copper, cadmium, zinc, cobalt and nickel as their thiocyanate complexes, both by paper and thin layer chromatographic methods, have been reported. In these, the metal ions were complexed *in situ* using both the thiocyanate ion and pyridine. The complexes thus formed were eluted suitably which are resolved from a mixture and can be suitably detected.

The available data on the solubility of thiocyanates of various metal ions were collected and incorporated in an expanded form of periodic table. A study of this indicated that several combinations of metal ions should be amenable to separation using thiocyanates as complexing agents. In the present work, titanium, uranium, thorium and zirconium were selected for study.

Previous workers have used different organic reagents, *viz.*, acetylacetone,<sup>4</sup> hydroxyquinoline,<sup>5</sup> dithizone,<sup>6</sup> etc., for the complexation of metal ions and found them advantageous in their chromatographic separation. The pyridine thiocyanate method developed by the present authors for Cu, Cd, Zn, Ni and Co could not be applied to titanium, uranium, zirconium and thorium for these get precipitated. In the present investigation, conditions like pH and composition of the eluant, etc., have been worked out for effecting their separation.

# Experimental

Following solutions were prepared :

- (a) Titanium, Zirconium, Uranyl and Thorium Solution: M/100 solutions of each were made.
- (b) Butanol: C.P. distilled.
- (c) Potassium thiocyanate: 1% solution.
- (d) Nitric acid.
- (e) 8-hydroxyquinoline (Oxine): 1% solution in 50% alcohol.

One drop each of the metal solution was applied separately on Whatman filter-paper No. 1 sheet. It was allowed to dry. It was then rolled in the form of a cylinder and kept in a trough covered with a bell-jar. A number of eluants were tried of which the following gave the best separation :

70 ml. of butanol was taken in a separating funnel. To it 70 ml. of 1% solution of pot. thiocyanate and 5 ml. of nitric acid (to make the aqueous solution 1N with respect to acid) was mixed. The mixture was shaken vigorously and the aqueous layer (lower portion) was drained off. The organic layer was used as the eluant. After keeping the filter-paper for 3-4 hours in a bell-jar (the time required for the development of chromatogram) it was taken out and allowed to dry. The spots of titanium (yellow) and of uranium (2 spots light orange) could be seen even visually.

**Detection of Titanium, Zirconium, Thorium and Uranyl Ions.**—1% solution of oxine was prepared in 50% ethanol and the filter-paper was sprayed with it. Afterwards aqueous solution of ammonia was also sprayed. The paper was put under ultraviolet light. The spot of zirconium showed bright fluorescence whereas uranium, titanium and thorium appeared as dark spots (Fig. 1). The  $R_f$  values

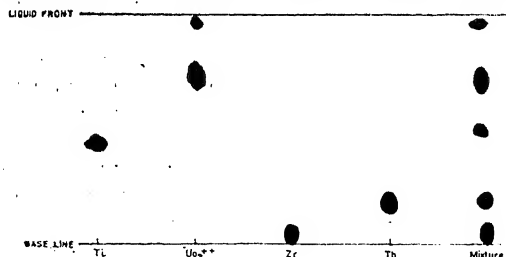


FIG. 1

of these metal ions are : titanium 0.4; uranyl 0.97 and 0.68; zirconium 0.05 and thorium 0.17.

National Physical Laboratory,  
New Delhi-12,  
February 10, 1968.

M. R. VERMA.  
P. K. GUPTA.

1. Verma, M. R. and Gupta, P. K., *Curr. Sci.*, 1961, **30**, 10.
2. — and —, *Ibid.*, 1962, **31**, 10.
3. — and Rai, J., *Ibid.*, 1966, **36**, 478.
4. Berg, E. W. and Strassur, J. E., *Analyt. Chem.*, 1955, **27**, 127.
5. Fernando, Q. and Phillips, J. P., *Ibid.*, 1953, **25**, 819.
6. Bhatnagar, R. P., Sharma, K. P. and Varshney, P. K., *J.S.I.R.*, 1966, **4**, 97.

## THE CRYSTAL STRUCTURE OF SODIUM HYDROGEN FUMARATE

As part of a programme for investigating the crystal structures of simple molecules, we have studied the sodium salts of the dicarboxylic fumaric acid,  $C_4H_4O_4$ . While disodium fumarate is monoclinic and a hydrate whose structure quickly collapses with the loss of water molecules, sodium hydrogen fumarate,  $NaC_4H_3O_4$ , is stable. This note gives a preliminary report of its crystal structure.

The crystallographic data for sodium hydrogen fumarate are as follows :

$$\begin{aligned} a &= 6.58_4 \text{ \AA} & a &= 87.85^\circ \\ b &= 7.93_0 \text{ \AA} & \beta &= 112.30^\circ \\ c &= 5.31_2 \text{ \AA} & \gamma &= 98.40^\circ \\ \rho &= 1.802 \text{ gm./c.c.} \\ \nu &= 253.8 \text{ \AA}^3 \\ Z &= 2 \end{aligned}$$

Linear absorption coefficient for  $CuK_\alpha$ ;  $\mu = 11.96 \text{ cm.}^{-1}$ . The lattice parameters were determined using high  $\sin \theta$  reflections on Weissenberg films with Ag lines as internal standards of calibration. We have collected complete three-dimensional data for the crystal using equi-inclination Weissenberg photography around the [001] and [101] axes.

There was considerable difficulty in locating the position of the sodium atom and when extensive trial and error methods failed, a three-dimensional Patterson synthesis was calculated which readily suggested possible sites for the sodium and some oxygen atoms surrounding it. The structure then refined quickly, and in the present stage of analysis, the R factors are as follows :

$$\begin{aligned} R(hko) &= 18.2\% \\ R(okl) &= 15.6\% \\ R(hol) &= 17.5\% \\ R(hkl) &\text{ with all observed} \\ &\text{reflections up to } \sin \theta \sim 0.6 \\ &= 21.0\% \end{aligned}$$

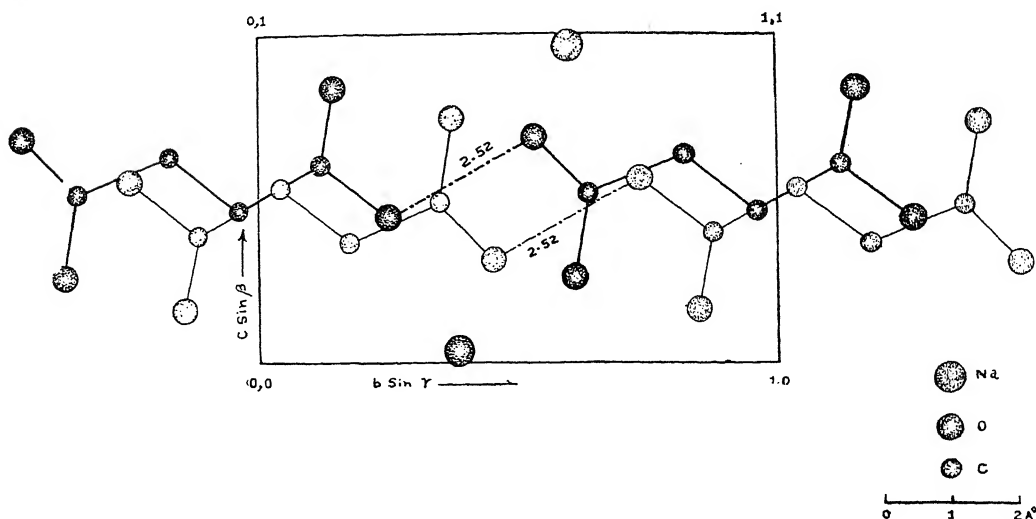


FIG. 1

The interesting features of the crystal structure are: (1) A short H-bond of 2.52 Å between two adjacent molecules, forming an extensive chain of molecules in the crystal roughly parallel to the [010] crystal axis (Fig. 1). The H-bonds are between two oxygen atoms, both of which are the longer of the two C-O bonds in a COOH group, (i.e. of the type OH...OH); (2) The bond lengths and angles are normal; (3) Six oxygen atoms surround the sodium with  $\text{Na}^+ \cdots \text{O}^-$  distances ranging from 2.30 Å to 2.97 Å; (4) The fumarate group is not quite planar.

The crystal structure is being refined using anisotropic temperature factors and as this refinement may take some time, we are presenting here only the essential features of this crystal structure.

University Dept. of Physics,  
University of Ranchi,  
Ranchi-8, January 5, 1968.

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### A SYNTHESIS OF THIOPHANIC ACID

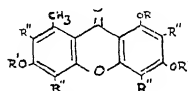
THIOPHANIC ACID is a yellowish crystalline substance first isolated by Hesse<sup>1</sup> from the lichen *Lecanora rupicola* (= *L. sordida*) and later by Kennedy *et al.*<sup>2</sup> from an Irish sample of the same lichen. Recently Huneck<sup>3</sup> has also reported the isolation of this substance from the same lichen and proposed its structure as 1, 3, 6-trihydroxy-2, 4, 5, 7-tetrachloro-8-methylxanthone (I) based on elemental analysis, spectral characteristics, chemical properties and biogenetic considerations. In the present com-

munication, a synthesis of thiophanic acid (I) is reported which confirms the structure proposed by Huneck.<sup>3</sup>

The present synthesis makes use of 1, 3, 6-trihydroxy-8-methylxanthone (*norlichexanthone*) (II) which is obtainable by the condensation of lecanoric acid and phloroglucinol in the presence of phosphorus oxychloride and anhydrous zinc chloride (unpublished work from this laboratory). The trihydroxy-xanthone (II) is subjected to complete methylation to the corresponding trimethyl ether (III) which is chlorinated by treating an ethereal solution of it with a solution of chlorine (4 moles) in carbon tetrachloride. The chlorinated methyl ether (IV), thus obtained, melts at 215-16° C. It undergoes demethylation with anhydrous aluminium chloride in benzene solution and the demethylated product, tetrachloro-*norlichexanthone*, crystallizes from benzene as yellow prisms, m.p. 243-44° C. It is found to be identical with a natural sample of thiophanic acid<sup>3</sup> in m.p., mixed m.p., spectral properties and colour reactions. The synthetic trimethyl ether (IV) agrees in m.p. and chemical properties with those reported for the trimethyl ether of natural thiophanic acid. It may be mentioned that our earlier efforts to chlorinate *norlichexanthone* (II) itself has not been successful in effecting the synthesis of thiophanic acid.

Thiophanic acid (I) is an interesting xanthone derivative of lichen origin and is the second example of a xanthone from this source, the first being lichexanthone<sup>4</sup> (V). It is also

significant that it is a fully substituted chloro derivative and in this respect it is comparable to the lichen substance, diploicin (VI) which



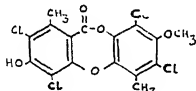
I, R = R' = H; R'' = Cl

II, R = R' = R'' = H

III, R = R' = CH<sub>3</sub>; R'' = H

IV, R = R' = CH<sub>3</sub>; R'' = Cl

V, R = R'' = H; R' = CH<sub>3</sub>



VI

is a tetrachlorodepsidone. A number of lichen constituents like methyl 3, 5-dichlorolecanorate, chloroatranorin, gangaleoidin, diploicin, pannarin and vicanicin are known to be chlorinated natural products.<sup>5</sup> Thiophanic acid (I) is another addition to this group of lichen substances.

Our thanks are due to Prof. S. Huneck, Technical University of Dresden, for the natural sample of thiophanic acid used for comparison.

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University of Delhi,  
Delhi-7, February 29, 1968.

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S. NEELAKANTAN,  
T. R. SESHADRI.

- 1 Hesse, O., *J. Prakt. Chem.*, 1898, **58**, 465.
- 2 Kennedy, G., Breen, J., Keane, J. and Nolan, T. J., *Sci. Proc. Roy. Dublin Soc.*, 1937, **21**, 557.
- 3 Huneck, S., *Tetrahedron Letters*, 1966, p. 3547.
- 4 Asahina, Y. and Nogami, H., *Bull. Chem. Soc. Japan*, 1942, **17**, 202.
- 5 Neelakantan, S. and Seshadri, T. R., *Proc. Nat. Inst. Sci. India*, 1960, **26 A**, Suppl. I, 84.

## QUANTITATIVE SEPARATION OF CADMIUM FROM COPPER AND ZINC

It is well known that it is difficult to test Cd<sup>2+</sup> in presence of Cu<sup>2+</sup> after Hg<sup>1+</sup>, Pb<sup>2+</sup>, Bi<sup>3+</sup> have been removed in the second 'A' group of qualitative analysis. Various methods have been suggested to overcome this difficulty. One of these is the use of KCN which forms a more stable complex with Cu<sup>2+</sup>, thereby preventing its precipitation as sulphide. Generally the reagent is not provided because of its highly poisonous nature. Alternatively, suitable adjustment of pH at which Cu<sup>2+</sup> could be precipitated as sulphide, is made use of. The method is cumbersome as accurate adjustment of pH and therefore complete removal of Cu<sup>2+</sup> is not so easy. Since the Cd<sup>2+</sup> is to

be precipitated as sulphide in very dilute solution, it has been observed that Cd<sup>2+</sup> is generally missed, even though it is present.

Further in the quantitative estimation of Cu<sup>2+</sup> or Zn<sup>2+</sup> by standard techniques such as titration with EDTA<sup>1</sup> or precipitation as quinadinate, etc., Cd<sup>2+</sup> interferes. Its quantitative separation from these metals is therefore essential.

To overcome these difficulties, the present investigation was carried out. This makes use of an observation by Dharmarha<sup>2</sup> regarding the relative stability of pyrophosphate complexes of Cu<sup>2+</sup>, Zn<sup>2+</sup> and Cd<sup>2+</sup>. He has reported that whereas the pyrophosphate complexes of copper and zinc are very stable, the cadmium pyrophosphate complex is unstable and decomposes in six hours at room temperature to give a silky white precipitate having a composition of cadmium: pyrophosphate as 3:1.

The present investigation has shown that the decomposition of cadmium pyrophosphate complex is hastened as the temperature is raised and is completed in minutes at about 100°C., particularly when the concentration of pyrophosphate is not very high. Making use of this fact, it has been possible to separate cadmium from a mixture of Cd<sup>2+</sup>, Cu<sup>2+</sup> and Zn<sup>2+</sup> quantitatively by the following method:

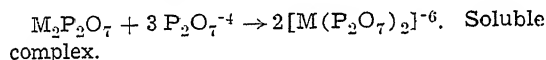
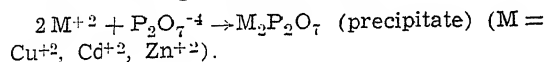
**Quantitative Separation of Cd<sup>2+</sup>.**—To the mixture solutions containing metal salts (CuSO<sub>4</sub> and/or ZnSO<sub>4</sub>) and CdSO<sub>4</sub> in the molar ratio of 2:1, 1:1 and 1:3, 5% solution of sodium pyrophosphate was added drop by drop till the precipitate formed just redissolved. The solutions were then heated nearly to boiling. A silky white precipitate separated out. After 15 minutes the precipitates were filtered off and washed. The filtrates and the washing were collected in clean beakers and acidified with dilute sulphuric acid. The amounts of Cu<sup>2+</sup> in the filtrates were then estimated iodometrically, and Zn<sup>2+</sup> volumetrically by titrating with EDTA using eriochrome black T as indicator and were found to be equivalents to the amounts of metal salts taken.

The precipitate containing cadmium was then dissolved in dilute HCl. The amount of cadmium was estimated by precipitating it as double ammonium phosphate and heating to Cd<sub>2</sub>P<sub>2</sub>O<sub>7</sub> in the usual manner. The quantities of Cd<sub>2</sub>P<sub>2</sub>O<sub>7</sub> thus obtained were also found to be equivalent to CdSO<sub>4</sub> taken in the mixtures with  $\pm 0.5\%$  error.

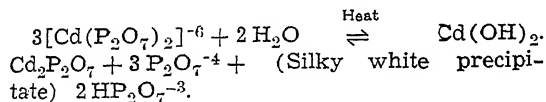
The method is of great significance in qualitative analysis for testing cadmium in the presence of copper as follows:

In the second 'A' group of qualitative analysis, to the just acidified mixture solution freed from  $\text{Hg}^{+2}$ ,  $\text{Pb}^{+4}$ ,  $\text{Bi}^{+3}$  in the usual manner and containing  $\text{Cu}^{+2}$  and  $\text{Cd}^{+2}$  only add 5% solution of  $\text{Na}_4\text{P}_2\text{O}_7$  drop by drop till a precipitate formed just redissolves. Heat the solution to boiling; if a silky white precipitate separates out,  $\text{Cd}^{+2}$  is present, otherwise it is absent. If present, filter the precipitate, wash and then dissolve it in dilute  $\text{HCl}$  (1:12) and pass  $\text{H}_2\text{S}$ . A yellow precipitate confirms  $\text{Cd}^{+2}$ . The identification of  $\text{Cu}^{+2}$  in the remaining solution involves no difficulty as it is readily tested by the addition of ammonium hydroxide in excess with which it gives deep blue colour of copper amines.

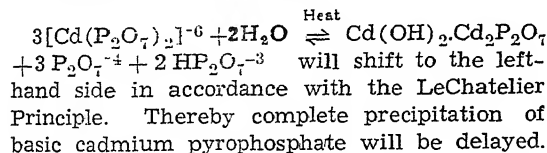
The following reactions occur:



However the  $[\text{Cd}(\text{P}_2\text{O}_7)_2]^{-6}$  complex is unstable and on heating decomposes and gives silky white precipitate.



This composition of the basic pyrophosphate has been reported by Dharmarha on the basis of physico-chemical evidences. Excess of  $\text{P}_2\text{O}_7^{-4}$  is to be avoided because in such a case, the equilibrium in the equation:



The author expresses his gratitude to Dr. O. P. Dharmarha for his valuable guidance.

S. G. T. B. Khalsa College, GURMUKH SINGH.  
Delhi, February 10, 1968.

### ENHANCEMENT OF ISOPROPANOL DEHYDROGENATION OF CHROMIA BY ACETIC ACID

It was reported in a previous note<sup>1</sup> that when mixtures of isopropanol and acetic acid containing more than 70 mole per cent. acid were passed over a chromia catalyst at  $460^\circ\text{C}$ ., there is an enhancement in the dehydrogenation of isopropanol as compared with the reaction when isopropanol is mixed with nitrogen, nitrogen being an inert diluent. It was suggested that the competitive adsorption of acetic acid creates additional dehydrogenation activity in the catalyst. To verify this suggestion, the relative change in the resistance ( $\Delta R/R_0$ ) of the catalyst was measured at  $460^\circ\text{C}$ . as the composition of the vapour phase was changed from pure acetic acid to pure nitrogen or from pure isopropanol to pure nitrogen. Measurements were also made with mixtures of acetic acid and isopropanol. The results are given in Fig. 1. The dotted line represents the resistance calculated for mixtures of isopropanol and acetic acid, assuming that they do not influence each other's effect on the catalyst.

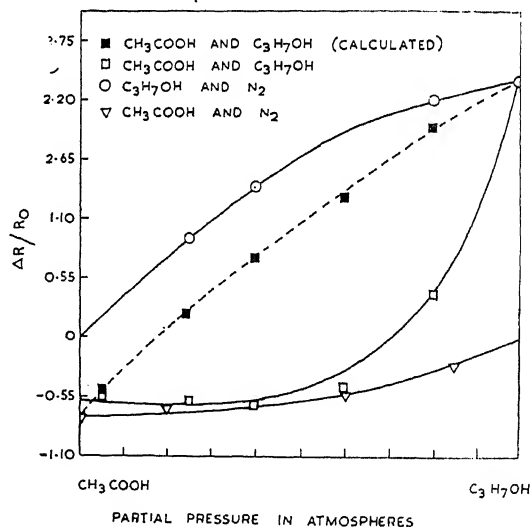


FIG. 1. Variation of relative resistance of chromia with composition of the gas phase.

At  $460^\circ\text{C}$ ., chromia is an  $n$ -type semiconductor.<sup>2,3</sup> The results show that acetic acid adsorption increases the electron concentration of the catalyst, while isopropanol adsorption decreases it. The non-coincidence of the experimental and calculated values for the relative change in resistance in mixed atmospheres of acetic acid and isopropanol suggests that the two compounds do not occupy exclusive areas

1. Vogel, *A Text-Book of Quantitative Inorganic Analysis*, 3rd Edition, pp. 390, 433, 533.
2. Dharmarha, O. P., *Ph.D. Thesis*, Submitted to Delhi University in 1964.

on the surface, but influence each other's adsorption. At a high partial pressure of acetic acid, the increase in electron concentration caused by the adsorption more than compensates for the decrease caused by isopropanol adsorption.

The rate of dehydrogenation can increase either due to an increase in the rate constant or an increase in the surface concentration of isopropanol. The rate constant can increase due to the lowering of the energy of activation consequent on a change in the mechanism or a change in the frequency factor. Acetic acid adsorption only increases the already present  $\pi$ -character of the chromia. Therefore, a change in mechanism and hence increase in rate constant is unlikely.

Acetic acid adsorption which increases the  $\pi$ -character of the chromia catalyst will help increase the adsorption of isopropanol which attracts electrons from the surface to itself on adsorption, thereby decreasing the  $\pi$ -character. Mixtures of these two compounds will thus mutually enhance each other's adsorption on chromia. A similar behaviour has been reported for the mixed adsorption of carbon monoxide and hydrogen on zinc oxide.<sup>4</sup> Thus, adsorption of acetic acid causes an increase in the surface concentration of isopropanol which nitrogen cannot do and hence the enhancement of dehydrogenation by acetic acid.

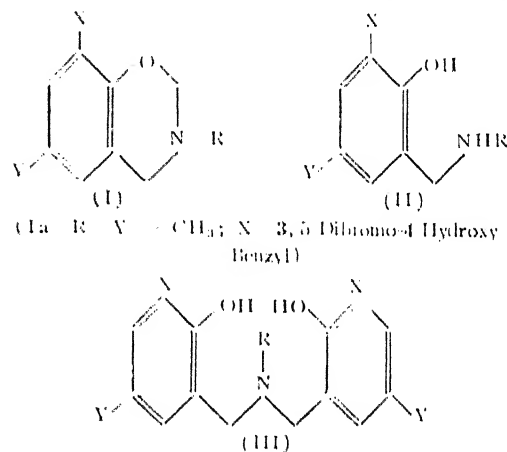
When the mole percentage of acetic acid is low in the mixtures of isopropanol and acid, there is an inhibition of the dehydrogenation.<sup>1</sup> A certain fraction of the chromia surface is apparently covered by acetic acid in a non-competitive manner, making the net chromia surface available for dehydrogenation less than if nitrogen and not acetic acid is present in mixture with isopropanol. This decrease in available surface and the inability of acetic acid to induce sufficient  $\pi$ -character at these low partial pressures to compensate for the diminution of surface, results in the inhibition of dehydrogenation.

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Madras-36, February 10, 1968.

## BENZOXAZINE DERIVED FROM SUBSTITUTED DIHYDROXY DIPHENYL METHANE

BURKE *et al.*<sup>1</sup> observed that the Mannich reaction involving phenols having a free ortho position, formaldehyde and primary amines yield substituted 3, 4-dihydro 2 H-1, 3-benzoxazines (I) in addition to 2-aminomethyl phenols (II) and N, N-bis (2-hydroxybenzyl) amines (III). The course of the reaction is influenced by a number of reaction variables,<sup>2,3</sup> the size of the ortho substituent on phenol playing an important role. For instance, efforts



to prepare I from a phenol having the bulky *t*-butyl group at the ortho position were unsuccessful and gave only III, while 4-*t*-butylphenol gave high yield of I.

This communication deals with the preparation of a benzoxazine (Ia) from a phenol having a bulky, substituted benzyl group at its ortho position, i.e., 3', 5'-dibromo-5-methyl-2, 4'-dihydroxydiphenylmethane (IV). In order to prepare the starting material (IV), equimolar amounts of 3, 5-dibromo-4-hydroxy benzyl bromide (V) and *p*-cresol were condensed at 125° C. in an atmosphere of  $\text{CO}_2$  for 12 hrs. in the presence of a small amount of *p*-toluene sulphonic acid. Recrystallisation from benzene gave white crystals (m.p. 201° C.) in 30% yield. This compound on analysis was found to be, not the expected product, but a trinuclear compound, 1-hydroxy-4-methyl-2, 6-bis (3, 5-dibromo-4-hydroxybenzyl) benzene formed by reaction at both the ortho position of *p*-cresol (Anal. Found: C, 39.4%; H, 2.34%. Calculated for  $\text{C}_{21}\text{H}_{16}\text{O}_3\text{Br}_4$ : C, 39.62%; H, 2.52%). However, condensation of V with ten times excess of *p*-cresol, followed by removal of unreacted *p*-cresol by steam distillation and

1. Swaminathan, R. and Kurucose, J. C., *Chem. Sci.*, 1967, **36**, 516.

2. Chaplin, R., Chapman, P. R. and Griffith, R. H., *Nature*, 1953, **172**, 77.

3. Garcia de la Bouda, I. E., *J. Catalysis*, 1962, **1**, 136.

4. Nagarajan, T. S., Sastri, M. V. C. and Kurucose, J. C., *ibid.*, 1963, **2**, 223.

recrystallisation from petroleum ether (60–80°) gave the expected dihydroxy diphenylmethane (IV) in 33% yield, m.p. 100–101° C. (Anal. Found: C, 45.55%; H, 3.68%. Calculated for  $C_{14}H_{12}O_2Br_2$ : C, 45.19%; H, 3.23%). Its I.R. spectrum shows a band at 818  $cm^{-1}$  due to the in-phase, out-of-plane wag of 2 adjacent ring H. The structure of this compound was further confirmed by its debromination with Ni–Al alloy and NaOH to the known compound, 5-methyl-2, 4'-dihydroxydiphenylmethane, m.p. 133° C. (lit.<sup>4</sup> 133–135° C.).

The Mannich reaction of IV was carried out as follows: To a solution of 0.42 g. (0.014 mole) of paraformaldehyde in 2.0 ml. ethanol-dioxane mixture (1:1) containing a small NaOH pellet, was added dropwise 25% methylamine solution (0.75 ml.) (0.006 mole) in 2.0 ml. dioxane followed by 2.32 g. (0.006 mole) of IV in 2.0 ml. dioxane. The mixture was heated at 65° C. for one hour and then at 85° C. for two hours. Evaporation of solvents at room temperature and extraction of the resinous mass with petroleum ether (60–80° C.) gave 3, 6-dimethyl-8-(3, 5-dibromo-4-hydroxybenzyl)-3, 4-dihydro-2 H-1, 3-benzoxazine (Ia). Recrystallised from petroleum ether. Colourless crystals. Yield 30%. m.p. 136° C. (Anal. Found: C, 48.08%; H, 4.17%; N, 4.00%. Calculated for  $C_{17}H_{17}O_2Br_2N$ : C, 47.78%; H, 3.98%; N, 3.28%). Its I.R. spectrum shows bands at 870  $cm^{-1}$  (in phase, out of plane wag of isolated ring H) and at 1280 and 1050  $cm^{-1}$  assigned to 'Aryl-O' and 'O-CH<sub>2</sub>' bands respectively of aralkyl ethers,<sup>5</sup> thus confirming the benzoxazine structure. As expected, the 818  $cm^{-1}$  band observed for IV was absent in the spectrum.

It is of interest to note that even at conditions favouring the formation of II, i.e., at equimolar concentration of phenol, formaldehyde and methylamine, in the absence of NaOH and using aqueous formaldehyde in dioxane, only the benzoxazine (Ia) could be isolated from IV in 14% yield. No crystalline product could be isolated when the Mannich reaction was carried out with the IV-formaldehyde-methylamine molar ratio of 2:2:1, in an attempt to prepare III.

Thanks are due to Dr. G. S. Krishna Rao, Indian Institute of Science, Bangalore, for supplying the I.R. spectra and micro-analytical

data and to Dr. S. S. Moosath for encouragement.

Chemistry Dept., K. I. MUHAMAD KUTTY.  
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P.O. Farook College, January 2, 1968.

1. Burke, W. J., *J. Amer. Chem. Soc.*, 1949, **71**, 609.
2. —, Smith, R. P. and Weatherbee, C., *Ibid.*, 1952, **74**, 602.
3. —, Kolbezen, M. J. and Stephens, C. W. *Ibid.*, 1952, **74**, 3601.
4. Carpenter, A. T. and Hunter, R. F., *J. Chem. Soc.*, 1954, p. 2731.
5. Colthup, N. B. *et al.*, *Introduction to Infra-red and Raman Spectroscopy*, Academic Press, 1964, pp. 227 & 270.

#### CHEMICAL STUDIES OF JASMINUM AURICULATUM (VAHL) LEAVES—III

AFTER removal of non-saponifiable matter by ether in the usual manner from 2.5 Kg. of dry leaves, the mixed fatty acids (62.5 gm., I.V. 106.4, S.E. 280) were obtained and were separated into "solid" acids (40%, I.V. 5.2, S.E. 272.6) and "liquid" acids (60%, I.V. 127.4, S.E. 290.6) by lead salt method.<sup>1</sup> These were converted separately into their methyl esters as usual and fractionally distilled under reduced pressure (0.1 mm., Hg). The weight, iodine value, saponification equivalent, and fatty acid composition of each fraction are given in Table I.

The acids were characterised further as palmitic, stearic, oleic and linoleic by reversed phase descending chromatography, using the following method.<sup>2</sup> The mixed fatty acids and reference acids in 1% acetone solution were spotted over chromatographic paper, Whatman No. 1, impregnated with 15% solution of liquid paraffin in dry benzene. These chromatograms were developed with 80% acetic acid solution at room temperature for 30 hr. (descending) and then dried. The fatty acids were thus revealed as light blue spots when chromatograms were dipped in aqueous saturated solution of copper sulphate for an hour and further as intense chocolate-coloured spots when the paper was dipped subsequently in 2.7% pot. ferrocyanide solution. The  $R_f$  values of each acid are listed in Table I.

It is therefore concluded that the main acids constituting the leaf fat of *J. auriculatum* (Vahl) are palmitic 31.54%, stearic 14.05%, oleic 28.76% and linoleic 25.72% acids which are the common constituents of other leaf fats.



TABLE I  
Component esters of solid(s) and liquid(L) acid fractions

Fractions	Wt. (gm.)	R.P. °C.	Palmiti	Stearic	Oleic	Undec.
Solid (s)*						
S <sub>1</sub>	2.61	80-120	2.42	0.17	0.02	..
S <sub>2</sub>	2.79	120-132	2.28	0.47	0.04	..
S <sub>3</sub>	3.32	132-142	2.50	0.63	0.19	..
S <sub>4</sub>	3.40	142-152	2.29	0.76	0.35	..
S <sub>5</sub>	3.49	152-157	1.36	0.70	0.43	..
Liquid (L)†						
L <sub>1</sub>	4.39	80-130	0.57	0.50	1.67	1.65
L <sub>2</sub>	3.24	130-140	0.21	0.26	1.39	1.38
L <sub>3</sub>	3.60	140-145	0.16	0.22	1.62	1.60
L <sub>4</sub>	3.59	145-148	0.13	0.20	1.64	1.62
L <sub>5</sub>	3.28	148-falling	0.10	0.15	1.52	1.51
Total wt. of solid acids ester (15.61 gm.)	..	..	10.85	3.73	1.0	..
*Percentage as esters	..	..	69.56	25.89	6.59	..
Percentage as acids	..	..	69.30	23.94	6.63	..
†Total wt. of liquid acids esters (18.10 gm.)	..	..	1.17	1.33	7.87	7.76
Percentage of esters	..	..	6.46	7.34	43.31	42.87
Percentage as acids	..	..	6.37	7.32	43.52	42.87
Overall percentage of acids	..	..	31.54	14.05	28.76	25.72
R <sub>f</sub> values over reversed phase chromatograms	..	..	0.58	0.60	0.20	0.26

Our thanks are due to Prof. G. B. Singh for providing necessary facilities and to Prof. S. P. Pathak for many technical suggestions. Department of Chemistry, B. M. Dhanasekar Organic Chem. Division, R. R. Upadhyay Banaras Hindu University, Varanasi-5 (India),  
December 27, 1967.

- Hilditch, T. P., *The Chemical Constitution of Natural Fats*, 2nd Edn., 1949, p. 408.
- Kaufmann, H. P. and Nitsch, W. H., *Extr. & Sapon.*, 1954, **56**, 154.

### CONTRIBUTION OF IRON AND ALUMINIUM IN PHOSPHATE SORPTION BY ALKALINE SOILS

IMPORTANCE of the role of iron and aluminium in phosphate sorption by acid soils has been demonstrated by many workers. The most direct argument is based on observations that phosphate sorption is reduced markedly when

both oxides are removed by chemical extraction.<sup>1,2</sup>

The importance of these oxides in phosphate sorption by alkaline soils has not been realized so far. The fractionation studies, by modified Chang and Jackson's method indicated that these soils also contain large amounts of iron and aluminium phosphates.<sup>3</sup> To assess the relative contribution of iron and aluminium in phosphate sorption in these soils and their effect on the forms of phosphorus, following study was carried out.

Six representative surface samples were selected for the study. The physical and chemical composition of these soils has already been reported.<sup>4</sup> These soils can be broadly classified into two groups, those containing more CaO and those containing less CaO.

The relevant data for one soil from each group is presented in Table I. The results for other soils are more or less identical.

TABLE I  
Showing phosphate sorption capacities and forms of phosphorus before and after removal of oxides of iron

Soils	Phosphate sorption capacity				Forms of phosphorus					
	A		B		Al P		Fe P		Ca P	
					A	B	A	B	A	B
Akola	890	436	172	76	8	17	210	234	4	1
		(51)		(44)						
Sakoli	456	250	183	103	73	74	74	15	6	4
		(55)		(56)						

A—Before removal, B—After removal, mgm P<sub>2</sub>O<sub>5</sub>/100 gm. of soil (on oven dry basis).  
Figures in brackets indicate the percentage reduction.

It has been observed that there is a considerable reduction in phosphate sorption capacities of these soils on removal of iron, ranging from 16 to 72%. Fractionation studies indicate that there is a reduction in aluminium bound phosphorus to the extent of 50% and no effect on other forms on removal of iron. Though the method of removal of iron is not specific and some amount of aluminium is also removed,<sup>5</sup> still the reduction in sorption capacity and aluminium bound phosphorus cannot account for the small amount of aluminium removed.

The conclusion drawn from the results with these soils is that the phosphate sorption in these soils is also considerably dominated by aluminium and not by iron. Presence of iron has an activating effect in sorption of phosphate by aluminium.

Dept. of Agri. Chemistry,  
Parbhani (M.S.),  
January 18, 1968.

M. V. BAPAT.

1. Wild, A., *Soil Sci.*, 1949, 1, 221.
2. Hemwell, J. B., *Advances on Agronomy*, Academic Press, Inc., New York, 1957, 9, 95.
- 3 & 4. Bapat, M. V. *et al.*, *J. Indian Soc. Soil Sci.*, 1965, 13, 31.
5. Broomfield, S. M., *Nature*, 1964, 201, 322.
6. Chang, S. C. and Jackson, M. L., *J. Soil Sci.*, 1958, 9, 109.

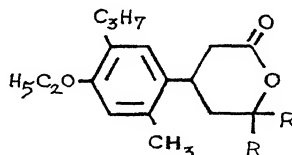
### SYNTHESIS OF 3-(2'-METHYL-4'-ETHOXY-5'-ISOPROPYLPHENYL)-5, 5-DISUBSTITUTED VALEROLACTONES

IN continuation of our work on substituted valerolactones as possible anthelmintics,<sup>1</sup> synthesis of 3-(2'-methyl-4'-ethoxy-5'-isopropylphenyl)-5, 5-disubstituted valerolactones was undertaken.

Various alkyl and aryl Grignard reagents were condensed with 3-(2'-methyl-4'-ethoxy-5'-isopropylphenyl)-glutaric anhydride<sup>2</sup> following the procedure of Weizmann<sup>3</sup> when valerolactones of the type I were obtained. Formation of I was confirmed through their elemental analysis and IR spectral studies. The physical characteristics of these valerolactones are described in Table I.

To a solution of one mole of anhydride in dry benzene, an ethereal solution of two moles of Grignard reagent was added with stirring and after the completion of addition, solvent ether was removed and the mixture was refluxed for 20 hr. The reaction mixture was then hydrolysed with ice and hydrochloric acid, extracted with ether, washed well with water and dried over anhydrous sodium sulphate. The extract upon concentration and subsequent crystallization or distillation gave desired valerolactones.

TABLE I  
General formula for lactones



I

Comp. No.	R	m.p./b.p. °C.	Yield %	Molecular formula	Composition %			
					Carbon		Hydrogen	
					Calcd.	Found	Calcd.	Found
1	Methyl	.. 119-120	39	C <sub>19</sub> H <sub>28</sub> O <sub>3</sub>	74.96	75.16	9.27	9.90
2	Ethyl	.. 105-106	40	C <sub>21</sub> H <sub>32</sub> O <sub>3</sub>	75.88	75.28	9.71	9.98
3	n-Butyl	.. 228-240/0.8 mm.	23	C <sub>25</sub> H <sub>40</sub> O <sub>3</sub>	77.27	77.97	10.38	10.04
4	Allyl	.. 220-222/0.5 mm.	17	C <sub>23</sub> H <sub>32</sub> O <sub>3</sub>	77.50	77.28	9.05	9.12
5	Phenyl	.. 238-240/0.7 mm.	34	C <sub>29</sub> H <sub>32</sub> O <sub>3</sub>	81.27	81.06	7.53	7.52
6	Benzyl	.. 106-107	24	C <sub>31</sub> H <sub>36</sub> O <sub>3</sub>	81.53	81.28	7.95	7.33
7	Anisyl	.. 176-178/0.4 mm.	Traces	C <sub>13</sub> H <sub>36</sub> O <sub>5</sub>	76.21	75.83	7.43	7.56

Department of Chemistry, S. N. AROSKAR.  
Tannarain Ruia College, R. A. KULKARNI.  
Bombay-19, January 30, 1968.

1. Kulkarni, R. A., Gawand, V. G., Kolli, M. S. and Palekar, A. D., *Indian J. Chem.* (In press).
2. Kulkarni, S. R., *M.Sc. Thesis*, University of Bombay, 1957.
3. Weizmann, C., Bergmann, E. and Bergmann, F., *J. Chem. Soc.*, 1935, p. 1367.

# A NOTE ON THE APPLICATION OF THE CONGLUTINATING COMPLEMENT ABSORPTION TEST FOR THE DETECTION OF RINDERPEST ANTIBODIES

ALTHOUGH various workers have reported the use of conglutinating complement absorption test as a sero-diagnostic tool in a number of viral diseases<sup>1</sup> there is no report on the use of this technique in sero-diagnosis of rinderpest. This communication describes briefly the application of this test and certain observations on the immunogenic response to rinderpest virus.

Three hundred serum samples from different species of animals were screened with this test. The serum samples were collected at different time intervals from buffalo calves and calves after vaccination with rinderpest goat-adapted virus vaccine. The cattle and buffalo sera were inactivated at 56° C. for 30 minutes.

Hyperimmune sera were raised in rabbits with 3-4 weekly intravenous injections of 0.5% lapinised rinderpest virus Nakamura II. The animals were bled 7-20 days after the last injection of the virus. Rabbit sera were inactivated at 62° C. for 30 minutes. Hyperimmune sera were also prepared in hill goats and calves by immunizing them with the goat-adapted virus followed by repeated large doses of virulent rinderpest virus.

The antigen was prepared from a pool of lymph nodes collected from goats at the height of reaction after they were infected with goat-adapted rinderpest virus. The lymph nodes were ground and freeze-dried. The dried material was kept at room temperature for two months. The antigen was extracted from this dried material at an alkaline pH by Nakamura's technique.<sup>3</sup> The pH of the antigen was adjusted to 7.5. The antigen was used at 1:4 dilution. Control antigen was derived from normal goat lymph nodes and was prepared in a similar manner.

Conglutinating complement absorption test employing standard procedure was carried out using different amounts of horse complement (ranging between 1.4-2 units) and an indicator system consisting of equal volumes of 1:20 heat-inactivated bovine serum and 0.25% sheep red cells. Primary incubation of antigen, antibody and complement was carried out at 18-20° C. for 30 minutes. Two unit volumes of the indicator system (previously incubated at 37° C. for 15 minutes) were added. The complete test was incubated at 37° C. for 30 minutes and thereafter all the tubes were centrifuged. The test was read by resuspension technique—a cloudy suspension of sheep R.B.Cs. indicated presence of antibodies whereas aggregated R.B.Cs. indicated absence of antibodies. The appropriate controls of antigen, serum, complement, etc., were included in each test.

Sera from forty animals have shown varying degrees of antibody response to rinderpest infection. It is found that detectable antibody titres were obtained after field vaccination and higher antibody titres were recorded after challenge with local virulent hill bull rinderpest virus. The antibodies were demonstrated as early as 5-7 days after inoculation until at least 40 days of vaccination or infection. The results of the conglutinating complement absorbing antibody levels in serial bleedings of two buffalo calves are presented in Fig. 1.

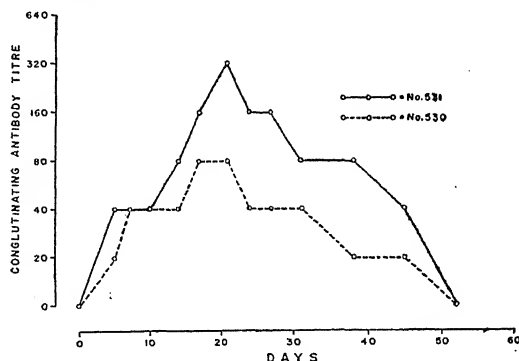


FIG. 1. Antibody response in buffalo calves (Nos. 530 and 531) following inoculation with goat-adapted rinderpest virus vaccine.

Reciprocal antibody titres as obtained after hyperimmunisation in rabbit and cattle sera were very high (Table I).

It appeared from the results that conglutinating complement absorption test could be employed for the demonstration of rinderpest antibodies in cattle and rabbit sera. The

amount of complement in the test seemed to play an important role and was chosen so as to obtain a positive result in a specific antigen-antibody reaction and a negative reading in its absence.

TABLE I  
Antibody titres of hyperimmune sera

Animal No.	Pre-immunisation serum	Post-immunisation serum
Rabbit 4	Nil	1 : 1280 (11)
" 5	"	1 : 640 (9)
" 6	"	1 : 640 (9, 11)
Hill bull 215	"	1 : 640 (10)

Figures in parentheses represent the number of days after the last injection.

One of the authors (G. S.) is thankful to the Council of Scientific and Industrial Research, New Delhi, for the award of a Research Fellowship.

Biological Products  
Division,  
Indian Vety. Res. Inst.,  
Izatnagar (U.P.), December 11, 1967.

GURKIRPAL SINGH.  
T. S. GULRAJANI.

1. Coombs, R. R. A., Coombs, Anne, M and Ingram, D. G., *Serology of Conglutination and its Relation to Disease*, Blackwell Scientific Publications, Oxford, 1961, p. 47.
2. Nakamura, J., *Complement Fixation Reaction in Rinderpest Study—Guide for Technique and Application*, Office Internationale des Epizooties, Paris, 1958, p. 4.

### OCCURRENCE OF ANDRADITE GARNET FROM CHANNAPATNA AREA, BANGALORE DISTRICT, MYSORE STATE

DURING the course of the geological investigation of Peninsular gneissic group of rocks around parts of Channapatna area, certain coarse-grained quartzo-feldspathic rocks of

pegmatitic nature, genetically related to the Peninsular gneisses, were noticed in a hill south-west of Singarajpur (Lat. 12° 33' 12" and Long. 77° 16' 21"), a village 15 kilometers south-east of Channapatna. These rocks are essentially composed of quartz, microcline-perthite, plagioclase and andradite garnet. Andradite occurs within this rock in the form of lenticles and knots, varying in size from 1 cm. to 8 cm. It is dull black in colour and is sometimes seen coated with an yellow alteration product, presumably limonite. The mineral is found to be more susceptible to physical weathering compared to other minerals of the host rocks and, as a result, it is easily removed, thus presenting a pitted appearance to the rock. The identification of the mineral as andradite is based on optical and chemical studies, whose results are given below:

In thin section, the mineral is yellowish-brown in colour with a number of cracks traversing it in random directions. The mineral shows high relief and is isotropic. A pure crop of the mineral was obtained from the crushed portions of the rock by following magnetic and gravity methods of separation. Refractive index was determined by employing the immersion technique, using sodium light. The refractive index value of the immersion liquid, matched with the mineral, was checked with the help of a Leitz-Jelly micro-refractometer. Specific gravity of the mineral was determined by using a pycnometer. Chemical analysis of the mineral was carried out by an adaptation of the methods of Shapiro and Brannock<sup>1</sup> and Riley.<sup>2</sup>

The structural formula of the mineral has been calculated and all the results obtained are shown in Table I.

TABLE I

Chemical analysis of andradite	Number of ions on the basis of 12 oxygen atoms	Mol. per cent. garnet molecule
SiO <sub>2</sub> .. 36.03	Si .. 2.997	3.000
Al <sub>2</sub> O <sub>3</sub> .. 2.20	Al .. 0.003	
Fe <sub>2</sub> O <sub>3</sub> .. 28.20	Al .. 0.187	
FeO .. 1.52	Fe <sup>+3</sup> .. 1.768	2.005
MnO .. 0.16	Ti .. 0.050	
TiO <sub>2</sub> .. 0.80	Fe <sup>+2</sup> .. 0.105	
CaO .. 29.07	Mn .. 0.015	3.018
MgO .. 2.10	Ca .. 2.598	
	Mg .. 0.300	
100.08		100.00
	R.I. = 1.890 ± 0.003	
	Specific gravity = 3.820	
	Analysed by : A. Kripanidhi	

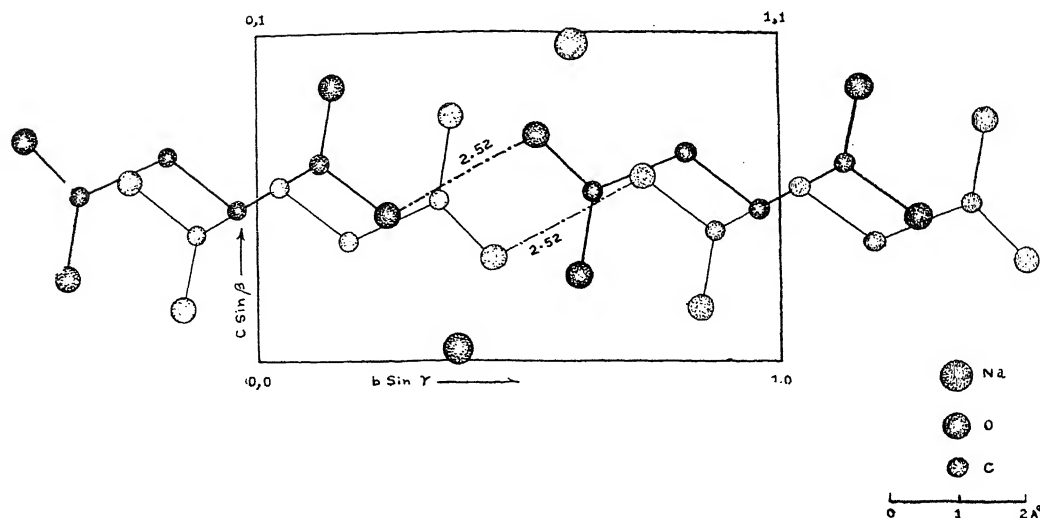


FIG. 1

The interesting features of the crystal structure are: (1) A short H-bond of 2.52 Å between two adjacent molecules, forming an extensive chain of molecules in the crystal roughly parallel to the [010] crystal axis (Fig. 1). The H-bonds are between two oxygen atoms, both of which are the longer of the two C-O bonds in a COOH group, (i.e. of the type OH...OH); (2) The bond lengths and angles are normal; (3) Six oxygen atoms surround the sodium with Na-O distances ranging from 2.30 Å to 2.97 Å; (4) The fumarate group is not quite planar.

The crystal structure is being refined using anisotropic temperature factors and as this refinement may take some time, we are presenting here only the essential features of this crystal structure.

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### A SYNTHESIS OF THIOPHANIC ACID

THIOPHANIC ACID is a yellowish crystalline substance first isolated by Hesse<sup>1</sup> from the lichen *Lecanora rupicola* (= *L. sordida*) and later by Kennedy *et al.*<sup>2</sup> from an Irish sample of the same lichen. Recently Huneck<sup>3</sup> has also reported the isolation of this substance from the same lichen and proposed its structure as 1, 3, 6-trihydroxy-2, 4, 5, 7-tetrachloro-8-methylxanthone (I) based on elemental analysis, spectral characteristics, chemical properties and biogenetic considerations. In the present com-

munication, a synthesis of thiophanic acid (I) is reported which confirms the structure proposed by Huneck.<sup>3</sup>

The present synthesis makes use of 1, 3, 6-trihydroxy-8-methylxanthone (*norlichexanthone*) (II) which is obtainable by the condensation of lecanoric acid and phloroglucinol in the presence of phosphorus oxychloride and anhydrous zinc chloride (unpublished work from this laboratory). The trihydroxy-xanthone (II) is subjected to complete methylation to the corresponding trimethyl ether (III) which is chlorinated by treating an ethereal solution of it with a solution of chlorine (4 moles) in carbon tetrachloride. The chlorinated methyl ether (IV), thus obtained, melts at 215-16° C. It undergoes demethylation with anhydrous aluminium chloride in benzene solution and the demethylated product, tetrachloro-*norlichexanthone*, crystallizes from benzene as yellow prisms, m.p. 243-44° C. It is found to be identical with a natural sample of thiophanic acid<sup>3</sup> in m.p., mixed m.p., spectral properties and colour reactions. The synthetic trimethyl ether (IV) agrees in m.p. and chemical properties with those reported for the trimethyl ether of natural thiophanic acid. It may be mentioned that our earlier efforts to chlorinate *norlichexanthone* (II) itself has not been successful in effecting the synthesis of thiophanic acid.

Thiophanic acid (I) is an interesting xanthone derivative of lichen origin and is the second example of a xanthone from this source, the first being lichexanthone<sup>4</sup> (V). It is also

recrystallisation from petroleum ether (60-80°) gave the expected dihydroxy diphenylmethane (IV) in 33% yield, m.p. 100-101° C. (Anal. Found: C, 45.55%; H, 3.68%. Calculated for  $C_{14}H_{12}O_2Br_2$ : C, 45.19%; H, 3.23%). Its I.R. spectrum shows a band at 818  $cm^{-1}$  due to the in-phase, out-of-plane wag of 2 adjacent ring H and another at 875  $cm^{-1}$  due to an isolated ring H. The structure of this compound was further confirmed by its debromination with Ni-Al alloy and NaOH to the known compound, 5-methyl-2, 4'-dihydroxydiphenylmethane, m.p. 133° C. (lit.<sup>4</sup> 133-135° C.).

The Mannich reaction of IV was carried out as follows: To a solution of 0.42 g. (0.014 mole) of paraformaldehyde in 2.0 ml. ethanol-dioxane mixture (1:1) containing a small NaOH pellet, was added dropwise 25% methylamine solution (0.75 ml.) (0.006 mole) in 2.0 ml. dioxane followed by 2.32 g. (0.006 mole) of IV in 2.0 ml. dioxane. The mixture was heated at 65° C. for one hour and then at 85° C. for two hours. Evaporation of solvents at room temperature and extraction of the resinous mass with petroleum ether (60-80° C.) gave 3,6-dimethyl-8-(3, 5-dibromo-4-hydroxybenzyl)-3, 4-dihydro-2 H-1, 3-benzoxazine (Ia). Recrystallised from petroleum ether. Colourless crystals. Yield 30%. m.p. 136° C. (Anal. Found: C, 48.08%; H, 4.17%; N, 4.00%. Calculated for  $C_{17}H_{17}O_2Br_2N$ : C, 47.78%; H, 3.98%; N, 3.28%). Its I.R. spectrum shows bands at 870  $cm^{-1}$  (in phase, out of plane wag of isolated ring H) and at 1280 and 1050  $cm^{-1}$  assigned to 'Aryl-O' and 'O-CH<sub>2</sub>' bands respectively of aralkyl ethers,<sup>5</sup> thus confirming the benzoxazine structure. As expected, the 818  $cm^{-1}$  band observed for IV was absent in the spectrum.

It is of interest to note that even at conditions favouring the formation of II, i.e., at equimolar concentration of phenol, formaldehyde and methylamine, in the absence of NaOH and using aqueous formaldehyde in dioxane, only the benzoxazine (Ia) could be isolated from IV in 14% yield. No crystalline product could be isolated when the Mannich reaction was carried out with the IV-formaldehyde-methylamine molar ratio of 2:2:1, in an attempt to prepare III.

Thanks are due to Dr. G. S. Krishna Rao, Indian Institute of Science, Bangalore, for supplying the I.R. spectra and micro-analytical

data and to Dr. S. S. Moosath for encouragement.

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Kerala University K. C. EAPEN.  
(Calicut Centre),  
P.O. Farook College, January 2, 1968.

1. Burke, W. J., *J. Amer. Chem. Soc.*, 1949, **71**, 609.
2. —, Smith, R. P. and Weatherbee, C., *Ibid.*, 1952, **74**, 602.
3. —, Kolbezen, M. J. and Stephens, C. W., *Ibid.*, 1952, **74**, 3601.
4. Carpenter, A. T. and Hunter, R. F., *J. Chem. Soc.*, 1954, p. 2731
5. Colthup, N. B. et al., *Introduction to Infrared and Raman Spectroscopy*, Academic Press, 1964, pp. 227 & 270.

### CHEMICAL STUDIES OF *JASMINUM AURICULATUM* (VAHL) LEAVES-III

AFTER removal of non-saponifiable matter by ether in the usual manner from 2.5 Kg. of dry leaves, the mixed fatty acids (62.5 gm., I.V. 106.4, S.E. 280) were obtained and were separated into "solid" acids (40%, I.V. 5.2, S.E. 272.6) and "liquid" acids (60%, I.V. 127.4, S.E. 290.6) by lead salt method.<sup>1</sup> These were converted separately into their methyl esters as usual and fractionally distilled under reduced pressure (0.1 mm., Hg). The weight, iodine value, saponification equivalent, and fatty acid composition of each fraction are given in Table I.

The acids were characterised further as palmitic, stearic, oleic and linoleic by reversed phase descending chromatography, using the following method.<sup>2</sup> The mixed fatty acids and reference acids in 1% acetone solution were spotted over chromatographic paper, Whatman No. 1, impregnated with 15% solution of liquid paraffin in dry benzene. These chromatograms were developed with 80% acetic acid solution at room temperature for 30 hr. (descending) and then dried. The fatty acids were thus revealed as light blue spots when chromatograms were dipped in aqueous saturated solution of copper sulphate for an hour and further as intense chocolate-coloured spots when the paper was dipped subsequently in 2.7% pot. ferrocyanide solution. The R<sub>f</sub> values of each acid are listed in Table I.

It is therefore concluded that the main acids constituting the leaf fat of *J. auriculatum* (Vahl) are palmitic 31.54%, stearic 14.05%, oleic 28.76% and linoleic 25.72% acids which are the common constituents of other leaf fats.

TABLE I  
Component esters of solid(s) and liquid(L) acid fractions

Fractions	Wt. (gm.),	B.P. °C.	Palmitic	Stearic	Oleic	Linoleic
Solid (s)*						
S <sub>1</sub>	2.61	80-120	2.42	0.17	0.02	..
S <sub>2</sub>	2.79	120-132	2.28	0.47	0.04	..
S <sub>3</sub>	3.32	132-142	2.50	0.63	0.19	..
S <sub>4</sub>	3.40	142-152	2.29	0.76	0.35	..
S <sub>5</sub>	3.49	152-157	1.36	0.70	0.43	..
Liquid (L)†						
L <sub>1</sub>	4.39	80-130	0.57	0.50	1.67	1.65
L <sub>2</sub>	3.24	130-140	0.21	0.26	1.39	1.38
L <sub>3</sub>	3.60	140-145	0.16	0.22	1.62	1.60
L <sub>4</sub>	3.59	145-148	0.13	0.20	1.64	1.62
L <sub>5</sub>	3.28	148-falling	0.10	0.15	1.52	1.51
Total wt. of solid acids ester (15.61 gm.)	..	..	10.85	3.73	1.0	..
*Percentage as esters	..	..	69.56	23.89	6.59	..
Percentage as acids	..	..	69.30	23.94	6.63	..
†Total wt. of liquid acids esters (18.10 gm.)	..	..	1.17	1.33	7.87	7.76
Percentage of esters	..	..	6.46	7.34	43.31	42.87
Percentage as acids	..	..	6.37	7.32	43.52	42.87
Overall percentage of acids	..	..	31.54	14.05	28.76	25.72
R <sub>f</sub> values over reserved phase chromatograms	..	..	0.58	0.60	0.20	0.26

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December 27, 1967.

1. Hilditch, T. P., *The Chemical Constitution of Natural Fats*, 2nd Edn., 1949, p. 468.
2. Kaufmann, H. P. and Nitsch, W. H., *Fette. U. Seifen.*, 1954, **56**, 154.

### CONTRIBUTION OF IRON AND ALUMINIUM IN PHOSPHATE SORPTION BY ALKALINE SOILS

IMPORTANCE of the role of iron and aluminium in phosphate sorption by acid soils has been demonstrated by many workers. The most direct argument is based on observations that phosphate sorption is reduced markedly when

both oxides are removed by chemical extraction.<sup>1,2</sup>

The importance of these oxides in phosphate sorption by alkaline soils has not been realized so far. The fractionation studies by modified Chang and Jackson's method indicated that these soils also contain large amounts of iron and aluminium phosphates.<sup>3</sup> To assess the relative contribution of iron and aluminium in phosphate sorption in these soils and their effect on the forms of phosphorus, following study was carried out.

Six representative surface samples were selected for the study. The physical and chemical composition of these soils has already been reported.<sup>4</sup> These soils can be broadly classified into two groups, those containing more CaO and those containing less CaO.

The relevant data for one soil from each group is presented in Table I. The results for other soils are more or less identical.

TABLE I  
Showing phosphate sorption capacities and forms of phosphorus before and after removal of oxides of iron

Phosphate sorption capacity			Forms of phosphorus							
Soils	A B		AL-P		Fe-P		Ca-P		Occluded-P	
	A	B	A	B	A	B	A	B	A	B
Akola	890	435 (51)	172	76 (44)	8	17	216	234	4	1
Sakoli	456	250 (55)	183	103 (56)	73	74	74	15	6	4

A—Before removal, B—After removal, mgm P<sub>2</sub>O<sub>5</sub>/100 gm. of soil (on oven-dry basis).  
Figures in brackets indicate the percentage reduction.

It has been observed that there is a considerable reduction in phosphate sorption capacities of these soils on removal of iron, ranging from 16 to 72%. Fractionation studies indicate that there is a reduction in aluminium bound phosphorus to the extent of 50% and no effect on other forms on removal of iron. Though the method of removal of iron is not specific and some amount of aluminium is also removed, still the reduction in sorption capacity and aluminium bound phosphorus cannot account for the small amount of aluminium removed.

The conclusion drawn from the results with these soils is that the phosphate sorption in these soils is also considerably dominated by aluminium and not by iron. Presence of iron has an activating effect in sorption of phosphate by aluminium.

Dept. of Agri. Chemistry,  
Parbhani (M.S.).  
January 13, 1968.

M. V. BAPAT.

1. Wild, A. *Soil Sci.*, 1949, 1, 221.
2. Hamwell, J. B. *Advances in Agronomy*, Academic Press, Inc., New York, 1957, 9, 95.
- 3 & 4. Bapat, M. V. *et al.*, *J. Indian Soc. Soil Sci.*, 1965, 13, 31.
5. Broadbent, S. M., *Nature*, 1964, 201, 322.
6. Chang, S. C. and Jackson, M. L., *J. Soil Sci.*, 1958, 9, 100.

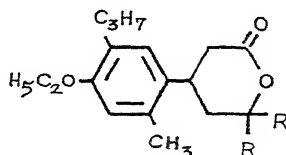
# SYNTHESIS OF 3-(2'-METHYL-4'-ETHOXY-5'-ISOPROPYLPHENYL)-5, 5-DISUBSTITUTED VALEROLACTONES

IN continuation of our work on substituted valerolactones as possible anthelmintics,<sup>1</sup> synthesis of 3-(2'-methyl-4'-ethoxy-5'-isopropylphenyl)-5, 5-disubstituted valerolactones was undertaken.

Various alkyl and aryl Grignard reagents were condensed with 3-(2'-methyl-4'-ethoxy-5'-isopropylphenyl)-glutaric anhydride<sup>2</sup> following the procedure of Weizmann<sup>3</sup> when valerolactones of the type I were obtained. Formation of I was confirmed through their elemental analysis and IR spectral studies. The physical characteristics of these valerolactones are described in Table I.

To a solution of one mole of anhydride in dry benzene, an ethereal solution of two moles of Grignard reagent was added with stirring and after the completion of addition, solvent ether was removed and the mixture was refluxed for 20 hr. The reaction mixture was then hydrolysed with ice and hydrochloric acid, extracted with ether, washed well with water and dried over anhydrous sodium sulphate. The extract upon concentration and subsequent crystallization or distillation gave desired valerolactones.

TABLE I  
General formula for lactones



I

Comp. No.	R	m.p./b.p. °C.	Yield %	Molecular formula	Composition %			
					Carbon		Hydrogen	
					Calcd.	Found	Calcd.	Found
1	Methyl	.. 119-120	39	C <sub>19</sub> H <sub>25</sub> O <sub>3</sub>	74.96	75.16	9.27	9.90
2	Ethyl	.. 105-106	40	C <sub>21</sub> H <sub>31</sub> O <sub>3</sub>	75.88	75.28	9.71	9.98
3	n-Propyl	.. 238-240 0.8 mm.	23	C <sub>25</sub> H <sub>40</sub> O <sub>3</sub>	77.27	77.97	10.38	10.04
4	Allyl	.. 250-252 0.5 mm.	17	C <sub>23</sub> H <sub>32</sub> O <sub>3</sub>	77.50	77.28	9.05	9.12
5	Benzyl	.. 238-240 0.7 mm.	34	C <sub>29</sub> H <sub>36</sub> O <sub>3</sub>	81.27	81.06	7.53	7.52
6	Phenyl	.. 106-107	24	C <sub>31</sub> H <sub>36</sub> O <sub>3</sub>	81.53	81.28	7.95	7.33
7	Acetyl	.. 176-178 0.4 mm.	Traces	C <sub>13</sub> H <sub>16</sub> O <sub>5</sub>	76.21	75.83	7.43	7.56



Department of Chemistry, S. N. AROSKAR.  
Ramnarain Ruia College, R. A. KULKARNI.  
Bombay-19, January 30, 1968.

1. Kulkarni, R. A., Gawand, V. G., Kolli, M. S. and Palekar, A. D., *Indian J. Chem.* (In press).
2. Kulkarni, S. R., *M.Sc. Thesis*, University of Bombay, 1957.
3. Weizmann, C., Bergmann, E. and Bergmann, F., *J. Chem. Soc.*, 1935, p. 1367.

# A NOTE ON THE APPLICATION OF THE CONGLUTINATING COMPLEMENT ABSORPTION TEST FOR THE DETECTION OF RINDERPEST ANTIBODIES

ALTHOUGH various workers have reported the use of conglutinating complement absorption test as a sero-diagnostic tool in a number of viral diseases<sup>1</sup> there is no report on the use of this technique in sero-diagnosis of rinderpest. This communication describes briefly the application of this test and certain observations on the immunogenic response to rinderpest virus.

Three hundred serum samples from different species of animals were screened with this test. The serum samples were collected at different time intervals from buffalo calves and calves after vaccination with rinderpest goat-adapted virus vaccine. The cattle and buffalo sera were inactivated at 56° C. for 30 minutes.

Hyperimmune sera were raised in rabbits with 3-4 weekly intravenous injections of 10% lapinised rinderpest virus Nakamura III. The animals were bled 7-20 days after the last injection of the virus. Rabbit sera were inactivated at 62° C. for 30 minutes. Hyperimmune sera were also prepared in hill bulls and calves by immunizing them with the goat-adapted virus followed by repeated large doses of virulent rinderpest virus.

The antigen was prepared from a pool of lymph nodes collected from goats at the height of reaction after they were infected with goat-adapted rinderpest virus. The lymph nodes were ground and freeze-dried. The dried material was kept at room temperature for two months. The antigen was extracted from this dried material at an alkaline pH by Nakamura's technique.<sup>3</sup> The pH of the antigen was adjusted to 7.5. The antigen was used at 1:4 dilution. Control antigen was derived from normal goat lymph nodes and was prepared in a similar manner.

Conglutinating complement absorption test employing standard procedure was carried out using different amounts of horse complement (ranging between 1.4-2 units) and an indicator system consisting of equal volumes of 1:20 heat-inactivated bovine serum and 0.25% sheep red cells. Primary incubation of antigen, antibody and complement was carried out at 18-20° C. for 30 minutes. Two unit volumes of the indicator system (previously incubated at 37° C. for 15 minutes) were added. The complete test was incubated at 37° C. for 30 minutes and thereafter all the tubes were centrifuged. The test was read by resuspension technique—a cloudy suspension of sheep R.B.Cs. indicated presence of antibodies whereas aggregated R.B.Cs. indicated absence of antibodies. The appropriate controls of antigen, serum, complement, etc., were included in each test.

Sera from forty animals have shown varying degrees of antibody response to rinderpest infection. It is found that detectable antibody titres were obtained after field vaccination and higher antibody titres were recorded after challenge with local virulent hill bull rinderpest virus. The antibodies were demonstrated as early as 5-7 days after inoculation until at least 40 days of vaccination or infection. The results of the conglutinating complement absorbing antibody levels in serial bleedings of two buffalo calves are presented in Fig. 1.

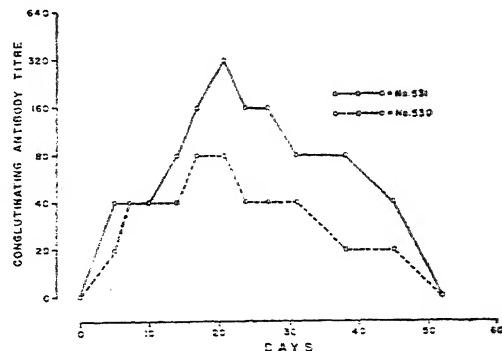


FIG. 1. Antibody response in buffalo calves (Nos. 530 and 531) following inoculation with goat-adapted rinderpest virus vaccine.

Reciprocal antibody titres as obtained after hyperimmunisation in rabbit and cattle sera were very high (Table I).

It appeared from the results that conglutinating complement absorption test could be employed for the demonstration of rinderpest antibodies in cattle and rabbit sera. The

amount of complement in the test seemed to play an important role and was chosen so as to obtain a positive result in a specific antigen-antibody reaction and a negative reading in its absence.

TABLE I  
Antibody titres of hyperimmune sera

Animal No.	Pre-immunisation serum	Post-immunisation serum
Rabbit 4 ..	Nil	1 : 1280 (11)
" 5 ..	"	1 : 640 (9)
" 6 ..	"	1 : 640 (9, 11)
HIM 215 ..	"	1 : 640 (10)

Figures in parentheses represent the number of days after the last injection.

One of the authors (G. S.) is thankful to the Council of Scientific and Industrial Research, New Delhi, for the award of a Research Fellowship.

Biological Products Division,  
Indian Vety. Res. Inst.,  
Izatnagar (U.P.), December 11, 1967.

GURKIRPAL SINGH.  
T. S. GULRAJANI.

1. Coombs, R. R. A., Coombs, Anne, M and Ingram, D. G., *Serology of Conglutination and its Relation to Disease*, Blackwell Scientific Publications, Oxford, 1961, p. 47.
2. Nakamura, J., *Complement Fixation Reaction in Rinderpest Study—Guide for Technique and Application*, Office Internationale des Epizooties, Paris, 1958, p. 4.

### OCCURRENCE OF ANDRADITE GARNET FROM CHANNAPATNA AREA, BANGALORE DISTRICT, MYSORE STATE

DURING the course of the geological investigation of Peninsular gneissic group of rocks around parts of Channapatna area, certain coarse-grained quartzo-feldspathic rocks of

pegmatitic nature, genetically related to the Peninsular gneisses, were noticed in a hill south-west of Singarajpur (Lat. 12° 33' 12" and Long. 77° 16' 21"), a village 15 kilometers south-east of Channapatna. These rocks are essentially composed of quartz, microcline-perthite, plagioclase and andradite garnet. Andradite occurs within this rock in the form of lenticles and knots, varying in size from 1 cm. to 8 cm. It is dull black in colour and is sometimes seen coated with an yellow alteration product, presumably limonite. The mineral is found to be more susceptible to physical weathering compared to other minerals of the host rocks and, as a result, it is easily removed, thus presenting a pitted appearance to the rock. The identification of the mineral as andradite is based on optical and chemical studies, whose results are given below :

In thin section, the mineral is yellowish-brown in colour with a number of cracks traversing it in random directions. The mineral shows high relief and is isotropic. A pure crop of the mineral was obtained from the crushed portions of the rock by following magnetic and gravity methods of separation. Refractive index was determined by employing the immersion technique, using sodium light. The refractive index value of the immersion liquid, matched with the mineral, was checked with the help of a Leitz-Jelly micro-refractometer. Specific gravity of the mineral was determined by using a pycnometer. Chemical analysis of the mineral was carried out by an adaptation of the methods of Shapiro and Brannock<sup>1</sup> and Riley.<sup>2</sup>

The structural formula of the mineral has been calculated and all the results obtained are shown in Table I.

TABLE I

Chemical analysis of andradite			Number of ions on the basis of 12 oxygen atoms			Mol. per cent. garnet molecule		
SiO <sub>2</sub>	..	36.03	Si	..	2.997	3.000		
Al <sub>2</sub> O <sub>3</sub>	..	2.20	Al	..	0.003			
Fe <sub>2</sub> O <sub>3</sub>	..	28.20	Al	..	0.187	2.005	Andradite	.. 87.16
FeO	..	1.52	Fe <sup>+2</sup>	..	1.768		Pyrope	.. 8.71
MnO	..	0.16	Ti	..	0.050	3.018	Almandine	.. 3.61
TiO <sub>2</sub>	..	0.80	Fe <sup>+2</sup>	..	0.105		Spessattite	.. 0.52
CaO	..	29.07	Mn	..	0.015			
MgO	..	2.10	Ca	..	2.598			
			Mg	..	0.300			100.00

R.I. = 1.890 ± 0.003  
Specific gravity = 3.820  
Analyser : A. Kripanidhi

Any theory for the origin of andradite should also account for its occurrence within the coarse-grained quartzo-feldspathic rock. The quartzo-feldspathic rock is related genetically to the Peninsular gneisses of this area. The Peninsular gneisses of this area are due to the injection of granitic solutions, into the pre-existing rocks (both igneous and sedimentary) during the course of regional metamorphism to which the area was subjected. The lighter constituents, that is, quartz and feldspar, everywhere, indicate their derivation from the granitic liquids. The presence of andradite in the quartzo-feldspathic rock indicates the contamination undergone by the magmatic solutions as a result of the incorporation of the sediments. These sediments have supplied the necessary amounts of calcium and iron to the solutions, thus injected, for the formation of andradite, within the quartzo-feldspathic rocks.

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Department of Geology, A. KRIPANIDHI.  
Sri Venkateswara University,  
Tirupati (A.P.), December 9, 1967.

1. Shapiro L. and Brannock, W. W., *U. S. Geol. Surv. Bul.*, 1956, p. 1036-C.
2. Riley, J. P., *Analyt. Chim. Acta*, 1958, 19, 413.

## CONTRIBUTION TO THE TERTIARY STRATIGRAPHY OF LAKHPAT AREA, KUTCH, GUJARAT\*

THE lower tertiary sediments of Lakhpat area in north-western Kutch were studied in considerable detail by Sen Gupta<sup>1</sup> who recognised several zones in the stratigraphical column ranging from Lutetian to Burdigalian. He found "absolutely no evidence of Paleocene-Lower Eocene sedimentation in Lakhpat area". In the course of a detailed study of the tertiary rocks of Kutch, we have discovered ample evidences to the contrary. The highly fossiliferous nodular limestones and shales exposed in the area about 2.5 km. S 50° E. of Lakhpat offer unmistakable evidences in support of Laki age of the sediments. Among the characteristic foraminifers, *Assilina daveisi*, *A. granulosa*, *A. spinosa*, *A. subspinosa*, numerous small *Nummulites* and *Operculina* are present in the limestones. Similar foraminiferal assemblage

suggestive of Lower Eocene Laki horizon was noted by Tandon<sup>2</sup> and the authors<sup>3</sup> from around Nareda, Baranda, Chakral, Harudi, Lakhmirani in North-Western Kutch.

Again, the Middle Oligocene (Stampian) horizon, which was noted in Kutch by Chatterji and Mathur,<sup>4</sup> is also very well represented in Lakhpat area. Limestones and shales exposed about 0.8 km. N 65° E. and 1.6 km. N 75° E. of Lakhpat fort Gate are at places full of *Lepidocyclina* (*Eulepidina*) *diffusa* accompanied by reticulate *Nummulites* suggestive of European Stampian equivalents.

Another significant find from Lakhpat area is the presence of *Nephrolepidina* (*Tryblielepidina*) in highly fossiliferous yellowish-brown limestones exposed in the area about 4 km. S 85° E. of Lakhpat. *Tryblielepidina* type of nucleonch is said to represent the highest evolutionary stage in *Nephrolepidina* and is supposed by some workers to be characteristic of Upper Burdigalian horizon. Thus *Nephrolepidina* (*Tryblielepidina*) associated with *Miogyssina* cf. *irregularis*, *Taberina malabarica* and *Austrotrillina howchini* may be taken as indicative of Upper Burdigalian horizon in Lakhpat area.

This is for the first time that evidences are put forward to establish the presence of Lower Eocene, Middle Oligocene and Upper Burdigalian horizons in Lakhpat area.

The authors are thankful to Shri M. V. A. Sastry for his guidance.

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Geological Survey of India, U. B. MATHUR,  
Calcutta-13, January 18, 1968.

\* Published with the kind permission of the Director-General, Geological Survey of India.

1. Sen Gupta, B. K., *Jour. Geol. Soc. Ind.*, 1954, 5, 138.
2. Tandon, K. K., *Curr. Sci.* 1962, 2, 63.
3. Pant, S. C. and Mathur, U. B., *Proc. Roy. Soc. Geol. Surv. Ind. for the Field Season*, 1966-67 (Unpublished).
4. Chatterji, A. K. and Mathur, U. B., *Ind. Geol. Soc. Ind.*, 1966, 3, 1, 9.

## FRANGOSPORA GEN. NOV., A NEW FOSSIL SPORE GENUS FROM THE BHUJ SERIES OF KUTCH, W. INDIA

THE present note deals with a new genus of pteridophytic spore recovered from the Lower Cretaceous (Bhuji) sediments of Kutch, W. India. The Bhuji Series, also known as the *Uinia* plant beds forms the uppermost limit of the Gondwana formations of India, and as such has attracted the attention of various

workers. Rajnath (1932)<sup>1</sup> has summarised the earlier work on the Geology of the area. Singh, Srivastava and Roy (1964),<sup>2</sup> Venkatachala (in press)<sup>3</sup> have assigned a Lower Cretaceous age to the Umia plant beds.

The spore genus described here is associated with other characteristic spore-pollen genera, viz. *Cyathidites* Couper, 1953; *Concavissimisporites* (Delcourt and Sprumont) Delcourt et al., 1963; *Trilobosporites* Pant ex Potonié, 1956; *Contignisporites* Dettmann, 1963; *Applanopsis* Doering, 1961; *Coptospora* Dettmann, 1963; *Aequitriradites* (Delcourt and Sprumont) Delcourt et al., 1963; *Cooksonites* Dettmann, 1963; *Araucariacites* Cookson ex Couper, 1953; *Laricoidites* Potonié et al., 1956; *Podocarpidites* Cookson ex Couper, 1953; *Microcachrydites* Cookson ex Couper, 1953; *Classopollis* (Pflug) Pocock and Jansonius, 1961; *Schizosporis* Cookson and Dettmann, 1959; etc. (Venkatachala, in press).<sup>4,5</sup> The palynological fossils were recovered from sediments exposed on the northern bank of the Pur river near Trambau village about 7 km. north-northeast of Bhuj. The exposure consists mostly of shales and sandstones and is measured as 55 ft. thick. 21 samples were collected for palynological study out of which only 4 samples yielded palynological fossils. The maceration procedure is essentially the same as enumerated by Venkatachala and Kar (1967).<sup>6</sup> The type slides are preserved in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

#### GENUS—*Frangospora* GEN. NOV.

Type Species.—*Frangospora fracta* sp. nov.

Type Locality.—Bhuj exposure, Section J, exposed on the Northern bank of the Pur river near Bhuj, Kutch (see Venkatachala,<sup>5</sup> in press, for details of locality).

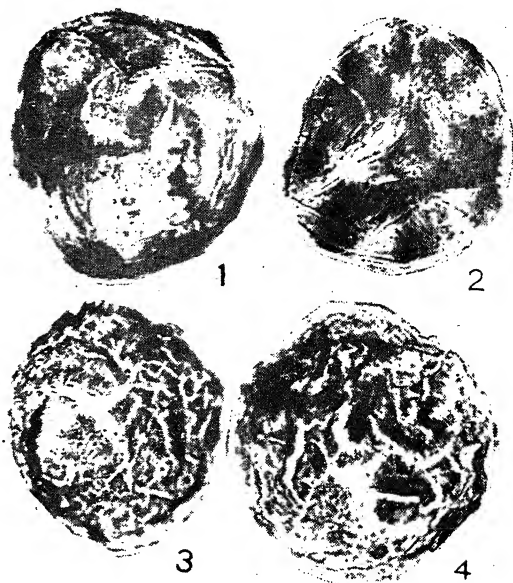
Generic Diagnosis.—Circular-subcircular. Trilete, rays  $3/4$  radius, tapering. Exine laevigate, sometimes infrastructured, unevenly thickened, outer exine splitting up by irregularly distributed cleavages giving the spore a mud-crack like appearance. The splitting is on both proximal and distal surfaces and do not conform to any set pattern.

Comparison.—*Cyathidites* Couper (1953)<sup>7</sup> is laevigate and faintly ornamented. *Camaronosporites* (Potonié) Klaus (1960)<sup>8</sup> approximates the present genus in shape but is distinguished by rugose sculpture. *Tigrisporites* Klaus (l.c.) and *Zebrasporites* Klaus (l.c.) are distinguished by set ornamentational pattern.

Some species of *Trilobosporites* Pant ex Potonié (1956)<sup>9</sup> and *Concavissimisporites* (Delcourt and Sprumont) Delcourt et al. (1963)<sup>10</sup> are comparable to *Frangospora* proposed here. The former is distinguished by its restricted angular, valvate ornamentation and the latter by uniformly distributed verrucae all over the spore body.

#### *Frangospora fracta* SP. NOV.

(FIGS. 1-4)



FIGS. 1-4. *Frangospora fracta* gen. et sp. nov. Fig. 1. *F. fracta* (Holotype) Ca.,  $\times 500$ . Slide No. Bha 8/2/29. Note the trilete mark, unevenly thickened exine splitting irregularly. Fig. 2. *F. fracta* (Isotype) Ca.,  $\times 500$ . Slide No. Bha 8/2/19. Note the subcircular type. Fig. 3. *F. fracta* Ca.,  $\times 500$ . Slide No. 5. 14/42. Note the open trilete mark and irregular splitting. Fig. 4. *F. fracta* Ca.,  $\times 560$ . Slide No. 5. 11/79.

Holotype.—Fig. 1; size  $72\mu$ .

Type Locality.—Same as for the genus.

Specific Diagnosis.—Circular-subcircular. trilete rays extending upto  $3/4$  radius,  $50-75\mu$ . Exine  $2-6\mu$  thick, unevenly thickened, laevigate and infragranulose, breaking up into irregular mounds. Canaliculate, equatorial margin undulating.

*Frangospora* is here designated to confine to circular-subcircular spores with a distinct, recognizable trilete mark and possessing a thick, uneven exine with occasional infrastructure and irregularly canaliculate exine separating into variously shaped mounds.

Derivation of name.—*Frango* (Latin) = to break, *Fracta* (Latin) = broken.

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1. Rajnath, *Quart. J. geol. Min. Met. Soc. India*, 1932, 4 (4), 161.
2. Singh, H. P., Srivastava, S. K. and Roy, S. K., *Palaeobotanist*, 1964, 12 (13), 282 (1963).
3. Venkatachala, B. S., *2nd Internat. Palyn. Cong.*, Utrecht. (in press).
4. —, *Palaeobotanist*. (In press).
5. —, *Ibid.*, (In press).
6. — and Kar, R. K., *Curr. Sci.*, 1967, 36 (22), 613.
7. Couper, R. A., *N.Z. Geol. Surv. Pal. Bull.*, 1953, 22, 1.
8. Klaus, W., *Jb. Geol.*, 1930, 5, 107.
9. Potonič, R., *Beih. geol. Jb.*, 1956, 23, 1.
10. Delcourt, A., Dettmann, M. E. and Hughes, N. F., *Palaeontologv*, 1963, 6 (2), 282

# OCURRENCE OF "GIANT MUSCLE FIBERS" IN THE FLIGHT MUSCLE OF *PANTALA FLAVESCENS* (F.) (LIBELLULIDAE: ODONATA)

CONSIDERABLE work has been done on the comparative histology of muscles in different groups of insects. Tiegs,<sup>1</sup> Pringle<sup>2</sup> and Boettiger<sup>3</sup> have reviewed the literature in detail and have given a structural classification of the different types of insect flight muscles. Our knowledge of the morphology of flight muscle fibers in the order Odonata is largely due to the work of Smith.<sup>4-6</sup> They have been described as tubular structures with radially arranged fibrils around a central core of nuclei. The diameter of the fibers generally ranges between 20 to 30  $\mu$ . There are well-developed radiating mitochondria, which appear as dark wedges, inserted between the light fibrils. Electron microscopic studies<sup>4</sup> have confirmed this basic structure.

The present study was conducted on *Pantala flavescens*. The dragonflies were collected while swarming; their head and abdomen were separated from the thorax which was then bisected under insect saline and immediately fixed in cold Baker's formal-calcium. The material was then embedded in gelatin and sections of 15 to 20  $\mu$  were cut on the freezing microtome. The sections were stained with Sudan Black B for further studies.

The organization of the flight muscle fibers was observed to be the same as described by earlier workers<sup>2-4</sup> (Fig. 1). There were, how-

ever, some fibers, which were much larger than the remaining ones (Figs. 2, 3).



FIGS. 1-3. Cross-section of flight muscle of *Pantala flavescens*. Stained with Sudan Black B showing the dark radiating mitochondria, alternating with light fibrils. Fig. 1. Normal fibers,  $\times 550$ . Fig. 2. Two giant fibers surrounded by normal fibers,  $\times 650$ . Fig. 3. A giant fiber under oil immersion,  $\times 1,000$ .

In a cross-section their diameter varied from 40 to 70  $\mu$ . This type of giant fibers were more abundant in dorsoventral and basalar muscles of meso and meta-thorax. They stained much lighter with Sudan Black B than the normal ones, indicating their lesser fat content. Their mitochondria however were much bigger in size.

Similar studies conducted on another dragonfly, *Brachythemis contaminata* (F.), which also belongs to the family Libellulidae, did not show the presence of these giant fibers.

The absence of giant muscle fibers in the flight muscle of some species of dragonflies, namely *Brachythemis contaminata* and *Aeshna* sp.<sup>1</sup> is a striking contrast from the structure observed in *Pantala flavescens*. Muscle hypertrophy generally results from continuous and prolonged exercise of the organ to cope up with high energy demand. *Pantala flavescens* is an efficient flier and remains in the air for long periods while swarming, thus giving continuous exercise to its flight muscle. This could probably account for the presence of giant muscle fibers in some species while they are absent in other species of dragonflies. But a more detailed study of flying habits of different species of dragonflies in relation to the structure of their flight muscle is necessary before coming to a definite conclusion.

I am grateful to Prof. J. C. George for his guidance. The financial assistance received from the U.G.C. in the form of scholarship during the present investigation is also gratefully acknowledged. My thanks are due to the Director, Commonwealth Institute of Entomology, London, for identifying the dragonflies used in the present study.

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1. Tiegs, O. W., *Phil. Trans.*, 1955, 238 B, 221.
2. Pringle, J. W. S., *Insect Flight*, Cambridge University Press, New York, N.Y., 1957, p 133.
3. Boettiger, E. G., *Ann. Rev. Ent.*, 1960, 5, 1.
4. Smith, D. S., *J. Biophys. Biochem. Cytol.* 1961, 11, 119.
5. —, *Scientific American*, 1965, 211, 77.
6. —, *J. Cell Biology*, 1966, 28, 109.

#### THE ABNORMAL SPADICES OF *BORASSUS FLABELLIFER* L.

The palmyra palm (*Borassus flabellifer* L.) is known to be strictly dioecious producing sparsely branched female spadices on female plants and the male plants with branched spadices bearing 1-3 spikes each.<sup>1-3</sup>

For six years a curious young palm has been observed producing every year both male and female spikes in a common spathe of a spadix. This peculiar spadix produced completely female flowers on one of the two spikes while the other spike bore numerous male flowers just above a few proximal female flowers. The pistillate flowers, however, were

abnormal, in the sense, the perianth lobes were small, the connate staminodes consisted of perfect anther lobes lacking pollen. Although the observed ovaries were tricarpellary syncarpous as in normal flowers, only one of the carpels was found to inherit the potentiality to set fruit, so much so, at a later stage of fruit growth, the developing fruit assumed a shape much similar to a pigeon head with a characteristic beak (Fig. 1). The pyrenes



FIG. 1. Abnormal spadix of *Borassus flabellifer* L. showing beaked fruits.

derived from such abnormal flowers were found to be viable producing seedlings. The male flowers of the plant under review were normal.

The above abnormality met within this genus, the authors consider, is more towards atavism since dioecious nature is regarded as derived from monecism.<sup>4</sup>

The authors thank Prof. I. M. Rao for encouragement.

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Tirupati (A.P.), December 13, 1967.

1. Roxburgh, W., *Flora Indica or Descriptions of Indian Plants*, Thacker & Company, London, 1874.
2. Hooker, J. D., *The Flora of British India*, L. Reeve & Company, Kent, 1894, 4.
3. Gamble, J. S., *Flora of the Presidency of Madras*, B.S.I., Calcutta, 1957, 3.
4. Hutchinson, J., *The Families of Flowering Plants*, Oxford, at the Clarendon Press, 1959, 1 & 2.

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## REVIEWS AND NOTICES OF BOOKS

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**Four Lectures on Relativity and Space.** By Charles Proteus Steinmetz. (Dover Publications, 180, Varick Street, New York), 1967. Pp. x + 142. Price \$ 1.35.

This Dover Edition, first published in 1967, is an unabridged republication of the work originally published by the McGraw-Hill Book Company Inc., in 1923.

The book's four lectures survey both the general and special theories of relativity, along with some of their implications. Among the topics covered are acceleration and the law of gravitation, mass and energy, the orbit of the beam of light, the finite volume of three-dimensional space, time effects, and the conception of mathematical space. The fourth lecture is unique in that it provides a full, descriptive survey of non-Euclidean geometry. This book will give beginning physics students, engineers, and intelligent laymen a good understanding of the nature of the relativity theory and its ramifications for modern thought.

C. V. R.

**A Concise History of Mathematics.** By Dirk J. Struik. (Dover Publications, Inc., 180, Varick Street, New York), 1967. Pp. vi + 195. Price \$ 2.00.

This Dover Edition, first published in 1967, is a revised and enlarged version of the work originally published in 1948.

Beginning with the ancient Near East, the author traces the ideas and techniques developed in Egypt, Babylonia, China and Arabia, looking into such ancient manuscripts as the Egyptian Papyrus Rhind, The Ten Classics of China, and the *Siddhantas* of India. He considers Greek and Roman developments from their beginnings in Ionian rationalism to the fall of Constantinople; covers Mediaeval European ideas and Renaissance trends; analyses 17th and 18th century contributions; and concludes with an exposition of 19th century concepts. Every important figure in mathematical history is dealt with—Euclid, Archimedes, Diophantus, Omar Khayyam, Boethius, Fermat, Pascal, Newton, Leibniz, Fourier, Gauss; Riemann, Cantor and many others.

C. V. R.

**Partial Differential Equations of Mathematical Physics (Vol. 2).** By A. N. Tychonov and A. A. Samarski. Translated by S. B. Radding. (Holden-Day, Inc., 500 Sansome Street, San Francisco). 1967. Pp. 379-621. Price \$ 11.75.

The present volume which is a continuation of the first volume in pagination and chaptering is devoted to the three-dimensional aspects of the material covered in the first volume (devoted to two-dimensional). Thus there are chapters on Spatial Wave Propagation, Spatial Heat Propagation, and continuation of the chapter on Elliptical Differential Equations which deals with problems leading to the differential equation  $\Delta v - cv = 0$ ; Green's Function, Radiation Principle, and Mathematical Theory of Diffraction. An Appendix chapter of about 100 pages deals with special functions, cylindrical and spherical functions, and the Tschebyscheff-Hermite and T-Laguerre Polynomials.

This two-volume text on Partial Differential Equations with its topics carefully chosen and developed, and supplemented by problems and exercises, will be a very useful text to senior students of mathematics, physics and engineering.

A. S. G.

**Topics in Several-Particle Dynamics.** By K. M. Watson and J. Nuttall. (Holden-Day, Inc., 500, Sansome Street, San Francisco). 1967. Pp. 121. Price \$ 8.25.

The book reviews several techniques for treating three-particle systems and other few-body systems that have proved useful. The monograph begins with a survey of relevant topics from the theory of integral equations. These are applied first to the two-body problem. Next, the three-body problem is discussed and related to many-body problem. A chapter on Partial Wave Analysis of Faddeev Equations is contributed by J. S. R. Chisholm.

A. S. G.

**Principles of Gas Lasers.** By L. Allen and D. G. C. Jones. [Butterworth & Co. (Publishers), Ltd., 88, Kingsway, London W.C. 2], 1967. Pp. 158. Price 48 sh.

The book gives an account of gas lasers at a level suitable for graduate students of



physics. The general principle of laser action (light amplification by stimulated emission of radiation) is explained in the first chapter. This is followed by chapters dealing with the theory of resonant optical cavities, and interaction of radiation with matter. The mechanism of population inversion in energy levels is explained and the working of the Helium-Neon laser is dealt with in detail. A chapter is devoted to coherence and its theory. The last chapter gives in brief the applications of gas lasers in communications, in the study of Raman effect, to metrology, and plasma diagnostics.

A. S. G.

**Optical Illusions.** By S. Tolansky. (Published by Pergamon Press, Ltd., Headington Hill Hall, Oxford), Pp. 157. Price 35 sh. net.

Optical illusions, although they continue to attract interest among the young and the puzzle-loving, have long ceased to be serious subjects of scientific study. Professor Tolansky, in this delightful little book, succeeds in reviving interest in this study. The book is chiefly concerned with geometrical optical illusion patterns, many of which are original, and their explanations. The illustrations effectively bring home how wrong one may be in one's visual judgement of distances and angles. The examples of the Moon in art are particularly instructive. How optical illusions can become matters of serious concern in scientific research is illustrated by the hatchings observed by the author in his study of diamond surfaces and shown in Figs. 74 and 75 of the book.

A. S. G.

**Sonar in Fisheries—A Forward Look.** By D. G. Tucker. [Published by Fishing (News Books) Ltd., 110, Fleet Street, London, E.C. 4]. Pp. 133. Price 37 sh. 6 d.

This book is a companion volume to the author's book "Underwater Observations Using Sonar" which was reviewed in these columns earlier (Curr. Sci., 1967, 36, 26). Underwater acoustics, in the form of the conventional echo-sounder, has come into general use by fishermen for both navigation and fish location. The author, a well-known electronic engineer, aims in this book current practice in sonar (and Navigation and Ranging) technique and also the directions in which it is progressing, and its possible greater potentialities. New developments in sonar electronics which have passed laboratory trials and are in the process of commercial manufacture have been explained

in an understandable manner with the aid of suitable diagrams. Emphasis is given to narrow-beam sector scanning.

A. S. G.

**Advances in X-Ray Analysis** (Vol. 10). Edited by J. B. Newkirk and Gavin R. Mallett. (Published by Plenum Press, 227, West 17th Street, New York, N.Y. 10011), Pp. 558. Price \$22.50.

This volume contains the Proceedings of the Fifteenth Annual Conference on Applications of X-ray Analysis, held in August 10-12, 1966, under the sponsorship of the University of Denver, Denver Research Institute. Starting from the Proceedings of the Sixth Conference issued in 1960, this continuing Series on Advances in X-ray Analysis published by Plenum Press, has been featuring latest developments in the applications of X-ray analysis in various fields of research. These volumes have become indispensable acquisitions to the libraries and research centres concerned with X-ray techniques and their applications.

The forty-four papers presented and discussed at the conference and included in this volume are concerned with X-ray Diffraction Topography, and Dynamical X-ray Phenomena, Structure of Solids, Stress Analysis, Fluorescent Analysis, Diffraction Techniques, Electron Microprobe, and Long Wavelength X-rays. They describe the current activities and achievements in the practical use of X-ray topography for detecting and displaying lattice defects, intrusions, faults, fatigue, stresses and strains, etc. Discussions have also been included at the end of each paper.

A. S. G.

#### Books Received

**American Astronautical Society Publications** (Vol. 4)—*Scientific Experiments for Manned Orbital Flights*. Edited by P. C. Badgley. (American Astronautical Society, Suite 500, 1629 K. Street, Washington D.C. 20006), Pp. xiv + 358; (Vol. 13)—*Physics of the Moon*. Edited by S. Fred. Singer. Pp. xi + 248. Price not given.

**Introduction to Carbohydrate Chemistry.** By R. J. McIlroy. (Butterworths Pub. Ltd., 88, Kingsway, London, W.C. 2), 1967, Pp. vii + 133. Price 21 sh.

**Farming in Hot Countries.** By A. Thomas. (Faber and Faber Ltd., 24 Russel Square, London), 1967, Pp. 180. Price 30 sh.

**Optical Illusions.** By S. Tolansky. (Pergamon Press, Ltd., Headington Hill Hall, Oxford), 1967. Pp. ix + 156. Price 35 sh.



# THE DIAMOND : ITS STRUCTURE AND PROPERTIES

SIR C. V. RAMAN

## ABSTRACT

A critical study of the crystal forms of diamond from various sources demonstrates that the symmetry of the structure may be either that of Class 32 or Class 31, in other words that the structure may be either centrosymmetric or non-centrosymmetric. Diamonds belonging to Class 31 may however exhibit a pseudo-octahedral symmetry of external form by reason of the interpenetration of oppositely directed structures having the lower symmetry. The existence of diamond with two differing structures provides an insight into the many remarkable properties of this material, *viz.*, the striking differences observed in the infra-red absorption spectra, differences in transparency to ultra-violet rays, the differences in the intensity of their X-ray reflections and the variations in the intensity and colour of the luminescence exhibited by them.

The modes of atomic vibration in diamond can be completely described and their frequencies evaluated by very simple procedures. The vibration frequencies can be determined experimentally by observations of the frequency shifts in the scattering of light or by infra-red spectroscopy, the results by the two methods being fully in agreement. The heat capacity of diamond may then be computed, giving results in highly satisfactory concordance with the observational data.

The principal mode of atomic vibration having a frequency of  $1332\text{ cm}^{-1}$  is triply degenerate. These vibrations can be excited in the lattice planes of diamond by the incidence of monochromatic X-rays if it belongs to crystal Class 31. The three-fold degeneracy of the vibration reveals itself as the three distinct spots in the resulting dynamic X-ray reflection by the octahedral lattice planes.

The complete electronic frequency spectrum of diamond has been evaluated by a very simple procedure. The results are highly successful in explaining the known optical and spectroscopic properties of diamond.

## 1. THE CRYSTAL FORMS OF DIAMOND

**G**EOMETRIC crystallography derives its significance from the fact that the external form of a crystal discloses the symmetry characters of its internal structure and that these characters are in their turn closely related to the physical properties of the solid. The study of the crystal forms of diamond thereby becomes a highly important first step towards an understanding of its many remarkable properties. It is a characteristic feature of diamond that it is generally found as single complete crystals which are bounded on all sides by the natural faces. The extreme hardness of the material

also enables it to preserve its original shape undamaged through many vicissitudes, so much so that specimens taken out of secondary geological formations usually exhibit the natural faces of the crystal with an undiminished brilliancy and lustre. These circumstances make the study of the crystal forms of diamond a highly rewarding pursuit.

As is well known, diamond belongs to the cubic system of crystals. There are five distinct classes in that system of which we are concerned here only with two, *viz.*, those which in the usual system of numbering are referred to respectively as Class 31 and Class 32. The symmetry properties of Class 31 are

the same as those exhibited by the geometric figure of a regular tetrahedron, while those of Class 32 similarly correspond to the symmetry of form of a perfect cube. Both of the classes possess six diagonal planes of symmetry, while Class 32 possesses in addition three axial planes of symmetry and a centre of symmetry. These additional features are not exhibited by Class 31.

In numerous cases, crystals of diamond of gem quality exhibit curved faces. In some diamonds one observes both plane and crystal faces in combination. There are also others which show plane faces almost exclusively. These circumstances have in the past led to much confusion and misunderstanding regarding the symmetry of the internal architecture of diamond and its relation to its external form. These difficulties however disappear if the following method of approach to the subject is adopted.

If the six diagonal planes of symmetry which are common to both Class 31 and 32 are drawn in space so that they intersect each other at some common point, and we then draw a closed surface around that point, it will be found that the surface appears divided up into 24 sectors. In the pattern thus formed on the surface, six points appear at which the diagonal planes of symmetry intersect each other in pairs, while at eight other points, three of the planes intersect each other. The six points are the projections of the mid-points of the six faces of a cube, while the eight other points are the projections of the eight cube corners. If, besides the six diagonal planes of symmetry, we had also drawn the three axial planes of symmetry in their proper setting, the entire surface would have appeared divided up into 48 sectors, six of these sectors being found

in each of the eight octants into which the surface would be divided up by the three mutually perpendicular axial symmetry planes.

Diamonds having only curved surfaces exhibit very varied shapes, but they all have certain features in common, namely that the exterior surface is not a single continuous sheet but is broken up into distinct areas by a pattern of sharply defined edges. This pattern exhibits the features referred to above appearing on a closed surface intersected by the six planes of diagonal symmetry of a cube. But we do not observe the features which would arise if the three axial planes of symmetry had been present. Thus, the externally observed features justify us in recognising such diamonds as crystals belonging to Class 31 and inferring from the absence of the features which distinguish Class 32 that they do not belong to Class 32.

On the other hand, the octahedron is the form which distinguishes Class 32 from Class 31 of the cubic system. Hence, if a diamond exhibits the form of a regular octahedron with plane faces and sharp straight edges, we have of necessity to recognise it as belonging to Class 32 of the cubic system and not to Class 31. Diamonds exhibiting this ideal form are not unknown. In particular, the author's collection of specimens includes some small crystals of octahedral form with lustrous plane faces bounded by sharp edges. Such specimens demonstrate beyond all possible doubt that the crystal symmetry of diamond may also be that of Class 32.

The conclusion thus arrived at, *viz.*, that some diamonds belong to Class 31 of the cubic system and that other diamonds belong to Class 32 of that system is of the highest importance. It is indeed the clue to the understanding of

many remarkable properties exhibited by diamond. Before we pass on to consider the subject of the crystal structure of diamond, it will be useful here to discuss its observed crystal forms a little more fully.

It is noteworthy that crystallographers and mineralogists have in the past been unanimous in assigning diamond to the tetrahedral class of the cubic system, in other words to Class 31. They were led to make this assignment by a study of the observed crystal forms. The appearance of simple tetrahedra with plane faces and of rounded forms exhibiting the general shape of a tetrahedron clearly indicated the lower symmetry. Further, octahedra with plane faces often exhibited notches or grooves along their edges which could be interpreted as the result of the twinning of oppositely directed tetrahedral forms. A particularly interesting case of this kind is that in which the octahedral faces are not triangular in shape but have a well-defined hexagonal outline, and all the edges of the octahedron are replaced by depressions bounded by these hexagons, each depression exhibiting four faces which intersect along sharply defined edges. The author's collection of diamonds includes a specimen from South Africa showing these features. An inspection of it makes it evident that the diamond is an interpenetration twin of two hexaxis-tetrahedra.

India was the original home of the great diamonds which found their way to other parts of the world and helped to spread the fame of this gemstone. At the present time, diamonds are still forthcoming at and near Panna in Central India. Two visits to Panna made by the author many years ago gave him the opportunity of inspecting numerous specimens of the diamonds found in that area in their original form as crystals. Particular

mention should be made of the magnificent set of 52 uncut diamonds ranging in size from 25 carats down to 2 carats strung together into a necklace by a predecessor of the Maharaja of Panna. The beauty of the necklace arises from the lustre and shapeliness of the gemstones. The two visits to Panna also enabled the author to acquire for his collection a set of specimens for a more detailed study.

The external features exhibited by the Panna diamonds in the collection are highly instructive. They are of very varied sizes and shapes. Two of them present a close resemblance to octahedra in their general shape. But the octahedral edges are not seen and indeed there is not the slightest indication of their presence. On the other hand, the edges along which the diagonal planes of symmetry meet the curved surface of the diamond are conspicuously visible. The six points where these planes intersect in pairs are located at the six vertices of the pseudo-octahedral form of the crystal, while the eight points at each of which three planes intersect appear at the centres of its eight curved faces. These features indicate that while the diamond has the inner symmetry of the tetrahedral class, its external form which mimics octahedral symmetry is the result of the interpenetration of oppositely directed tetrahedral forms within the diamond.

In some of the Panna diamonds, the lower or tetrahedral symmetry is much more obviously exhibited in the externally observed forms of the diamond than in others. There are also several specimens in which the external shape of the diamond resembles neither an octahedron nor a tetrahedron but is almost spherical in form. But in all cases the curved surfaces clearly exhibit the ridges where

they are intersected by the six diagonal planes of symmetry of the tetrahedron.

## 2. THE TWO TYPES OF DIAMOND

The difference between the diamonds belonging respectively to Classes 32 and 31 in respect of their symmetry properties is the same as the difference between the geometric forms of a regular octahedron and a regular tetrahedron, *viz.*, that the former possesses a centre of symmetry whereas the latter does not. In other words, the two kinds of diamond may be described as being respectively of the centrosymmetric and non-centrosymmetric types. Two physical tests for ascertaining whether the structure of diamond does or does not possess centres of symmetry may be suggested. One is whether diamond exhibits piezo-electric or pyro-electric behaviour. The other is the study of its behaviour in respect of the absorption of infra-red radiation. In regard to the former, it may be remarked that since diamond consists of atoms all of one kind, *viz.*, carbon, which are linked together by covalent bonds, the possibility of detecting piezo-electric or pyro-electric behaviour is exceedingly remote and may indeed be safely left out of consideration. On the other hand, the infra-red behaviour of diamond is readily tested. It is most conveniently studied with polished cleavage plates of diamond. Many such plates, including some of large size are included in the author's collection. Studies made with these plates and a recording infra-red spectrophotometer are described and discussed in the author's Memoir No. 129 entitled "The Infra-Red Absorption by Diamond and Its Significance". The reader is invited to study this memoir and examine the numerous figures and photographs reproduced in it. They show clearly that the existence of centrosymmetric and non-centrosymmetric types

of diamonds inferred from the study of the crystal forms is amply confirmed by the results of infra-red spectroscopy.

It is a noteworthy fact that the diamonds which exhibit an absorption of infra-red radiation in the spectral region of the fundamental atomic vibration frequencies are those which are revealed to be perfect diamonds when examined by various tests. It is thereby made evident that the absorptive power for infra-red radiation which they exhibit is an inherent property ascribable to their possessing a non-centrosymmetric structure. It is also significant that those diamonds which do not exhibit any infra-red absorption in those spectral regions and hence by inference are of the centrosymmetric class nevertheless exhibit an absorption of the second and higher orders, in other words of the overtones of the fundamental vibrational modes. In respect of this second-order absorption, the non-centrosymmetric and the centrosymmetric diamonds exhibit a precisely similar behaviour. This is a further and independent proof that the difference in behaviour of the two types of diamonds is a consequence of differences in their crystal symmetry. What exactly is the nature of the structural difference between the centrosymmetric and non-centrosymmetric diamonds is a question which will be dealt with a little later. It may here be pointed out that the differences in the infra-red behaviour go hand in hand with differences of a striking nature in respect of other properties. In particular, the centrosymmetric diamonds are found to be non-luminescent under ultra-violet irradiation, whereas the non-centrosymmetric diamonds exhibit a readily observable luminescence. The centrosymmetric diamonds exhibit a high degree of transparency to the near ultraviolet region of the spectrum, whereas the non-centrosymmetric diamonds show a strong

absorption in the same region. These relationships have been demonstrated by appropriate methods and illustrated in the Memoir No. 129 already mentioned.

### 3. NORMAL VIBRATIONS OF CRYSTAL STRUCTURES

A fundamental theorem in dynamics due to Lagrange states that the small vibrations of a system of connected particles may be expressed as a summation of a set of normal modes with precisely defined frequencies in each of which the particles of the system all move in the same or opposite phases and that the number of such modes is equal to the number of degrees of freedom of movement in the system. The theorem sets no limit to the number of particles contained in the system and it is obvious that it provides the correct approach to the subject of the dynamics of crystal lattices in its relation to the theory of the specific heats of crystals and of their spectroscopic behaviour. The simplicity of the crystal structure of diamond enables us on the basis of this definition of the normal modes of vibration of its structure to describe them fully and proceed to the evaluation of their frequencies. These topics are dealt with fully in Parts VI, VII and VIII of Memoir No. 129 and the frequencies as computed and as observed in the records of infrared absorption have been compared with each other.

It will suffice briefly to recall the findings. It emerges that the diamond has nine normal modes of atomic vibration, the principal mode of highest frequency being that in which the two interpenetrating lattices of carbon atoms of which the diamond is composed oscillate as units against each other. The other eight modes may be described as oscillations of the layers of carbon atoms present in the octahedral and cubic planes

respectively, either normally or tangentially to themselves, and the adjacent layers being either in the same or in the opposite phases.

### 4. SPECTRAL SHIFTS IN LIGHT SCATTERING

The discovery made by the author in February 1928 that monochromatic light diffused in a crystal is accompanied by additional radiations of altered frequency provides an extremely simple and precise method of identifying the modes of atomic vibration in crystals. On the basis of his earliest observations, the author in his address to the Faraday Society at its Bristol meeting in September 1929 suggested that the more perfectly ordered is the atomic space-grouping in a crystal, the sharper would be the lines recorded as frequency shifts in its spectrum of light-scattering. A striking confirmation of this emerged from the observation made soon afterwards that even with a very small diamond, a very sharp and intense line with a frequency shift of 1332 wave-numbers per second is recorded. This frequency shift arises from the mode of vibration of the diamond structure with the highest frequency.

None of the other fundamental modes of vibration of the diamond structure can manifest itself as a frequency shift for the reason that the alternation of phase of the movement as we pass from each cell of the structure to the next would cancel out the effects to be expected. It would be possible, however, for the modes to manifest themselves as overtones with doubled frequency shifts or also as summational frequency shifts. The effects thus arising would naturally be extremely feeble. In practice, they would be overpowered by the spectrum of the luminescence of diamond which is simultaneously recorded. The efforts made to record the second-order spectrum of diamond in the scattering of light

proved successful only when non-luminescent diamonds were available and use was made of the intense excitation provided by the  $\lambda$  2537 resonance-radiation of a water-cooled magnet-controlled mercury lamp. The second-order spectrum of diamond as actually recorded in this manner exhibits features in excellent agreement with what is to be expected on the basis of the dynamic theory and other relevant considerations.

A very sharp line which is recorded at one end of the spectrum with a frequency shift of 2666 wave-numbers is clearly identifiable as the octave of the highest fundamental frequency of 1332 wave-numbers. Another line which stands out clearly near the other end of the spectrum with the frequency shift of 2176 is clearly the octave of the frequency 1087 which is that of the oscillation of the cubic layers in the crystal normally to themselves. A strong band covers the range of frequency shifts from 2540 to 2450 and has a peak intensity at 2460. This arises from the superposition of the octaves and summation of the two frequencies 1273 and 1219, these being respectively the eight-fold and the six-fold degenerate oscillations tangential to themselves of the octahedral and cubic layers of atoms. The frequencies of 1176, 1010, 746 and 624 respectively are not recorded in the second-order spectrum of light-scattering.

The non-appearance of some of the vibrational modes and the observed relative strength of those which are actually recorded as octaves or summations in the second-order spectrum can be fully explained on the basis of the nature of the respective modes. It should be stated here that the spectrum of light-scattering and the spectrum of infra-red absorption do not differ noticeably in respect of the frequencies of the modes of vibration manifested therein. But the intensity

relationships are altogether different in the two cases, as is indeed to be expected in view of the wholly different mechanisms involved.

##### 5. THE DYNAMIC REFLEXION OF X-RAYS

Under the title of "A New X-ray Effect", the author with his assistant Nilakantan announced in the issue of *Current Science* for April 1940, the discovery of a highly remarkable phenomenon exhibited by diamond when a pencil of X-rays emitted by a copper target passes through it and the diffracted X-rays are recorded on a photographic plate. The specimen employed was a cleavage plate normal to the octahedral planes of the crystal. The diamond itself was of the type described earlier in this article as non-centrosymmetric, in other words, a diamond which does not give any sensible restoration of light when examined between crossed polaroids and displays infra-red activity both of the first and the second orders. The original publication of April, 1940 was followed by several others in the *Proceedings of the Indian Academy of Sciences* in the years 1940 and 1941. Owing to unavoidable reasons, the subject was then laid aside and could be resumed only after many years when more powerful X-ray equipment became available. The results and conclusions then arrived at are set out in the author's Memoir No. 109 entitled "The Diffraction of X-rays by Diamond". Numerous illustrations of the phenomenon as observed in various settings of the crystal are reproduced in it.

Studies on the crystal perfection of the diamonds actually used in the work described in Memoir No. 109 were made by single crystal and double-crystal X-ray spectroscopic methods. The results of the examination proved that they were absolutely perfect or ideal diamonds as is shown by their spectra which have

been reproduced in the same memoir. It was further demonstrated by photographs appearing in the memoir that the X-ray diffraction effects observed exhibit the same type of symmetry as the diamond itself; for example, the different sets of octahedral planes give identically similar results. Using a diamond which was a triangular twin, its two components show precisely similar effects turned round through  $60^\circ$ . It was thus firmly established that the effects under study were truly characteristic of the diamond crystal.

The importance of the studies described in Memoir No. 109 is that they demonstrate the effect discovered in the year 1940 to be a reflection of monochromatic X-rays by the lattice planes of the crystal with a small but quite definite change of frequency and that this X-ray effect is exactly analogous to the optical effect observed in the scattering of monochromatic light by diamond, with the difference that it is only exhibited by diamonds which are infra-red active in respect of the fundamental vibration of the frequency of 1332 wave-numbers, whereas the optical effect can be observed with all diamonds. The dynamical theory shows that this mode of vibration of the crystal structure of diamond is triply degenerate: in other words, it occurs along any of the three cubic axes of the crystal. This is beautifully confirmed by the fact that in appropriate settings of the diamond, the dynamic X-ray reflection by each octahedral plane appears as three well-separated spots: the reflections by other lattice planes show analogous effects in accord with the theoretical considerations developed in the memoir.

The possibility of observing the dynamic X-ray reflections by diamond arises because the mode of vibration of the structure which gives rise to them is

highly monochromatic and repeats itself in the same fashion as we pass from cell to cell in the structure. Thus, the appearance of these reflections is itself a demonstration of the correctness of the approach to the dynamical theory of the atomic vibrations in diamond set out in Memoir No. 129.

## 6. THE TETRAHEDRAL CARBON ATOM

As has been described earlier, the study of the crystal forms of diamond leads us to conclude that there are two types of diamond of which the inner structures are respectively centrosymmetric and non-centrosymmetric. Actual observation shows that the diamonds of the centrosymmetric type exhibit the infra-red absorption of the second order only, whereas diamonds of the non-centrosymmetric type exhibit both the first and second-order infra-red absorptions. Observation also shows that these same two types of diamond exhibit noteworthy differences in respect of their transmitting power for light appearing in the near ultra-violet part of the spectrum. Finally, we have the remarkable differences in the X-ray diffraction phenomena which they exhibit. Taking these facts into consideration, we are obliged to infer that we are here concerned with a fundamental difference in the symmetry characters of the binding of the carbon atoms within the crystal with each other.

Diamond may be very simply described as the result of two sets of carbon atoms holding each other in place, each atom of one set being surrounded by four others in a tetrahedral setting. The local symmetry at the centre of each carbon atom is only tetrahedral. What the symmetry of the structure is which results from the linking together of each carbon atom with four others depends on the nature of the linking. This question is



fully discussed in the author's Memoir No. 104 entitled "The Tetrahedral Carbon Atom and the Structure of Diamond". It has been shown that there are indeed alternative possibilities for the nature of the binding between the carbon atoms which do not involve any difference in the charges of the atoms, nor any difference in the energy of their binding.

The approach to the problem indicated in Memoir No. 104 enables us to understand why diamonds whose symmetry of structure is only tetrahedral may nevertheless succeed in exhibiting a pseudo-octahedral symmetry of form. The oppositely directed tetrahedral forms of the structure are indistinguishable from each other except in their geometric setting. Hence, they can freely intermingle with each other and the aggregate thus formed would tend to mimic octahedral symmetry to a greater or less extent. The aggregate would only be approximately but not absolutely homogeneous. The way is thus opened to a deeper understanding of various recondite properties of diamond, as we shall presently see.

#### 7. THE LUMINESCENCE SPECTRA OF DIAMOND

For a diamond to exhibit luminescence under ultra-violet irradiation, it is clearly necessary that it should be capable of absorbing the incident radiation. Diamonds of the non-centrosymmetric type exhibit a blue luminescence of which the intensity varies enormously with the specimen under study. Spectroscopic examination reveals that these diamonds exhibit an absorption band located near the violet end of the spectrum. Further, at exactly the same wavelength, an emission band appears in the spectrum of luminescence. A lowering of the temperature of diamond to  $-180^{\circ}\text{C}$ . results in a spectral sharpening of both the absorption and the emission with a shift

towards shorter wavelengths. *Per contra*, raising the temperature of the diamond results in a great increase in their spectral widths. With the diamond held at  $-180^{\circ}\text{C}$ ., the sharpened line appears at  $\lambda 4153$ . This is accompanied in emission towards greater wavelengths and in absorption towards smaller wavelengths by a system of bands exhibiting an observable discrete structure. Measurements show that these bands owe their origin to the vibrations of the diamond structure accompanying the change in the electronic energy levels which manifests itself as the emission or absorption at  $\lambda 4153$ .

The enormous variations in the strength of the blue luminescence as between different diamonds is readily understood in terms of the non-homogeneity of structure due to the intermingling of the positive and negative tetrahedral forms in the substance of the diamond. The greater the number of the discrete blocks in the aggregate, in other words, the greater is the mosaicity of the structure of the diamond, the more intense would be its luminescence and the stronger would be the associated absorption of light. This explanation is confirmed by the experimental result that the intensity of the ordinary X-ray reflections by the lattice planes increases *pari passu* with the intensity of its luminescence. The angular width of the reflection of monochromatic X-rays also increases in the same circumstances.

A second type of luminescence having a greenish-yellow colour is exhibited by many diamonds. Spectroscopic examination of this luminescence with the diamond held at a temperature of  $-180^{\circ}\text{C}$ . reveals that it arises from an emission band at  $\lambda 5032$  accompanied by a vibrational band system at greater wavelengths. Likewise and in the same circumstances, these diamonds exhibit an



absorption band at  $\lambda 5032$  accompanied towards lesser wavelengths by vibrational bands. This type of luminescence is found to be exhibited by diamonds of a composite type, in other words, by diamonds in which both the centrosymmetric and the non-centrosymmetric are located in juxtaposition. In such cases, the luminescence is exhibited by the diamond as a set of parallel streaks over its area and not as continuously distributed within its volume. Photographs exhibiting these features have been reproduced in Memoir No. 129.

#### 8. THE ELECTRONIC SPECTRUM OF DIAMOND

Each of the carbon atoms in diamond has a shell of four electrons surrounding the nucleus. These electrons play the principal role in holding the atoms together in the ordered structure of the crystal. The atomic vibration frequencies are determined by the strength of such binding and by the masses of the atomic nuclei and they appear in the infra-red range of the spectrum. If, on the other hand, we assume the nuclei to be at rest and only the electrons to be disturbed from their positions of equilibrium, their oscillations would appear in the ultra-violet region. To evaluate the modes and frequencies of electronic vibration, we may proceed on the assumption that all four electrons in the shell behave as a single unit of which the mass is four times that of an electron, and that these shells oscillate around their positions of equilibrium in the same manner as the atomic nuclei in the vibrations of infra-red frequencies. The evaluation of the electronic spectrum of diamond then becomes a simple matter. We have only to multiply the infra-red frequencies by the square root of the ratio between the mass of a carbon atom and the mass of the four electrons taken together. The

results of thus evaluating the electronic spectrum of diamond are shown in Table I.

TABLE I  
*Evaluation of electronic frequencies*

Mode	Degeneracy	Atomic vibration frequency (wave-numbers)	Electronic spectrum (wavelengths)
I	3	$1332 \text{ cm}^{-1}$	$1010 \text{ \AA}$
II	8	1273 "	1057 "
III	6	1219 "	1104 "
IV	4	1176 "	1144 "
V & VI	3+3	1087 "	1238 "
VII	4	1010 "	1332 "
VIII	6	746 "	1804 "
IX	8	624 "	2157 "

The following results emerge from Table I. The electronic spectrum of diamond consists of a set of eight monochromatic frequencies which lie in the ultra-violet range. The highest frequency corresponds to the wavelength  $\lambda 1010$  and the lowest frequency to the wavelength  $\lambda 2157$ . That this evaluation is highly successful in describing the actual behaviour of diamond is evident. The cut-off wavelength for diamond in the ultra-violet is  $\lambda 2240$ , which is close to the greatest wavelength of  $\lambda 2157$  appearing in Table I. The highest frequency represented by the wavelength  $\lambda 1010$  would be that principally responsible for the optical dispersion of diamond, while the others of greater wavelengths would play only minor roles. This follows from the fact that only the mode of highest frequency repeats itself from cell to cell of the structure, while the others alternate in phase and their first-order effects would therefore cancel out. The refractive index of diamond in the

spectral range extending from the red in the visible to the limit of transmission in the ultra-violet has been determined with great care by Peters. It is accurately represented by the formula given by him

$$(n^2 - 1) = \frac{\epsilon_1 \lambda^2}{\lambda^2 - \lambda_1^2} + \frac{\epsilon_2 \lambda^2}{\lambda^2 - \lambda_2^2}$$

where  $\epsilon_1 = 4.3356$ ,  $\epsilon_2 = 0.3306$ ,  $\lambda_1 = 1060$  Angstroms and  $\lambda_2 = 1750$  Angstroms. It will be seen that  $\epsilon_1$  is far larger than  $\epsilon_2$  and that the wavelength  $\lambda_1$  is reasonably close to the smallest wavelength  $\lambda_{1010}$  appearing in Table I. The difference between this wavelength and the wavelength  $\lambda_{1060}$  which appears in the two-term dispersion formula of Peters may be explained as arising from the small contributions made by the adjoining modes of lower frequency listed in Table I. The formula fits the observed data of dispersion for both types of diamond in a very satisfactory manner.

#### 9. THE ULTRA-VIOLET ABSORPTION SPECTRA

The electronic spectrum of diamond as shown in Table I consists of eight monochromatic wavelengths in the ultra-violet. But when the transmission of ultra-violet radiation through a plate of diamond of the centrosymmetric type is examined, what is observed is a complete cut-off of the spectrum over the entire range of wavelengths covered by Table I. How is this discrepancy to be explained? We are assisted in finding the answer to this question by the fact that the wavelength at which the cut-off appears shifts with the temperature at which the diamond is held, altering from  $\lambda_{2393}$  at  $314^\circ \text{C.}$  to  $\lambda_{2240}$  at  $-174^\circ \text{C.}$  It is thereby made evident that the thermal agitation strongly influences the strength of the absorption by diamond. We have also to take note of the fact that the excitation of electronic vibrations by the incident radiation would be accompanied

by the excitation of vibrations of the infra-red frequencies and of their overtones. In consequence, the frequencies at which absorption could occur would be very numerous and not eight only. Even at the temperature of liquid air, the thermal broadening of the electronic lines would not be negligible. Inevitably, therefore, the final result would be in the nature of a complete cut-off for any moderate thickness of the absorbing plate.

When the diamond is of the non-centrosymmetric type, there is a sensible absorption of wavelengths greater than  $\lambda_{2240}$  instead of free transmission as in case of the centrosymmetric diamonds. Much depends on the actual thickness of the plate of diamond with which the observations are made. A plate which has a thickness of only a tenth of a millimetre exhibits a sensible transmission for wavelengths less than  $\lambda_{3000}$ , the cut-off then being located at  $\lambda_{2240}$  as in the case of diamonds of the other kind. But if the thickness is a few millimetres, there is practically complete extinction up to  $\lambda_{3000}$ . A noteworthy feature is manifested by these diamonds, *viz.*, the appearance of a series of absorption maxima in the spectrum. By cooling the diamond to  $-180^\circ \text{C.}$  and by using diamonds of appropriate thickness, and a spectrograph of adequate resolving power and suitably regulating the exposures, it is possible to record and measure exactly the positions of as many as 25 distinct lines in the wavelength range between  $\lambda_{3347}$  and  $\lambda_{3015}$ . Some of these lines are of considerable intensity, and others are less conspicuous. Further out in the ultra-violet between  $\lambda_{2240}$  and  $\lambda_{3015}$ , it is possible to record and measure other absorption minima, the most conspicuous of them being the sharp doublet  $\lambda_{2356}$ - $\lambda_{2360}$  and the doublet  $\lambda_{2296}$ - $\lambda_{2298}$ .

Two questions here arise calling for an answer. What is the origin of the absorp-

tion observed in the region of wavelengths greater than  $\lambda 2240$ , and why does its spectrum exhibit a series of sharply-defined lines? Further, why is this absorption exhibited only by diamonds having a non-centrosymmetric structure? In considering these questions, it should be remarked that there are no measurable differences in refractivity between the two types of diamond. It may be inferred from this that the electronic spectrum exhibited in Table I is identical for both types of diamond and that the absorption frequencies manifested in the region under consideration make no sensible contribution to refractivity. A possible explanation of this situation is that these absorptions arise from the same set of electronic frequencies as those listed in Table I, but *diminished* by the subtraction therefrom of the overtones of various orders of the infra-red frequencies. The subtractions would yield a series of discrete frequencies, the strength with which they are manifested decreasing rapidly in the higher orders. If the process of such absorption is regarded as involving a kind of infra-red activity, their non-appearance with centrosymmetric diamonds and their manifestation with diamonds of the other type becomes intelligible.

Before leaving this topic, we may remark that the manifestation of a whole series of sharp lines in the absorption spectrum of diamond is a convincing demonstration that the electronic spectrum of diamond is not continuous but exhibits a discrete and enumerable set of sharply defined frequencies, capable of manifesting themselves as such in appropriate circumstances.

#### 10. THERMAL AND THERMO-OPTIC BEHAVIOUR OF DIAMOND

Utilizing the spectroscopically determined frequencies of atomic vibration

with their respective degeneracies as listed in Table I, it is a simple matter to evaluate the heat-capacity of diamond over the entire range of temperatures from  $0^\circ$  to  $1000^\circ$  absolute. The Einstein functions multiplied by the respective degeneracies for each of the atomic vibration frequencies may be added up. We then add the contribution to the thermal energy made by the three omitted degrees of frequencies representing the translations of the atoms. The total is divided by 48. We thereby obtain a representation of the variation of specific heat with temperature which exhibits a very satisfactory agreement with the facts of observation. The calculations are fully set out in Part X of the author's Memoir No. 129. It is, therefore, unnecessary to traverse the same ground here.

A remarkable property of diamond is that its refractive index increases with the temperature, indeed more and more rapidly as we proceed to higher temperatures. Studies of this phenomenon have shown it to be a consequence of the progressive fall with temperature of the characteristic dispersion frequencies of diamond. The characteristic frequencies in the infra-red also exhibit a similar fall which is also proportionately the same. This can readily be understood in view of the electronic and infra-red frequencies being related to each other as shown in Table I.

As an illustrative example, it may be mentioned that the principal vibration frequency which is  $1333 \text{ cm.}^{-1}$  at  $-180^\circ \text{ C.}$  falls to 1332 at  $30^\circ \text{ C.}$ , to 1327 at  $320^\circ \text{ C.}$  and to 1321 at  $630^\circ \text{ C.}$  and to 1316 at  $850^\circ \text{ C.}$  The corresponding frequency shift as observed in the spectrum of light scattering remains remarkably sharp over the whole of this temperature range.

## LETTERS TO THE EDITOR

A NOTE ON COUPLED WAVE  
EQUATIONS FOR HOMOGENEOUS  
GYROTROPIC COMPRESSIBLE  
WARM PLASMA

STARTING from the following fundamental equations, namely,

Maxwell's equations:

$$\vec{\nabla} \times \vec{E} = -j\omega\mu_0\vec{H} \quad (1a)$$

$$\vec{\nabla} \times \vec{H} = j\omega\epsilon_0\vec{E} - eN_0\vec{u} \quad (1b)$$

linearized hydrodynamic equation:

$$mN_0(j\omega + \nu)\vec{u} + \vec{\nabla}p + eN_0(\vec{E} + \mu_0\vec{u} \times \vec{H}_0) = 0 \quad (1c)$$

and equation of continuity combined with that of state:

$$a^2mN_0\vec{\nabla} \cdot \vec{u} + j\omega p = 0 \quad (1d)$$

it is possible to derive coupled wave equations for homogeneous, gyrotropic, compressible, warm, one fluid electron plasma, assuming all field variations as  $\exp(j\omega t)$  and using small signal theory. For this derivation the static magnetic field is taken as constant and solely along  $z$  direction, and it is assumed that there is no variation of dynamic fields along  $z$ -axis, so that

$$\vec{\nabla} \equiv \vec{\nabla}_t \quad (2)$$

where  $\vec{\nabla}_t$  denotes a del operation in the transverse plane.

The symbols in the above equations have the following meanings:

$\epsilon_0$ : permittivity of free space,

$\mu_0$ : permeability of free space,

$e$ : electron charge,

$m$ : electron mass,

$N_0$ : ambient electron population density in plasma,

$p$ : pressure deviation of electrons from the mean,

$\nu$ : collision frequency,

$a$ : velocity of electroacoustic wave,

$\omega$ : angular source frequency,

$\vec{H}_0$ : external magnetic field vector,

$\vec{u}$ : electron velocity vector,

$\vec{E}$ : electric field vector,

$\vec{H}$ : magnetic field vector.

As a direct consequence of the condition (2) and the assumed nature of the external magnetic field  $\vec{H}_0$ , one may put down for the operator:

$$(\vec{H}_0 \cdot \vec{\nabla}) \equiv 0 \quad (3)$$

and by identities the following relations for  $z$  components:

$$[\vec{\nabla} \times \vec{u} \times \vec{H}_0]_z = -H_0(\vec{\nabla} \cdot \vec{u}) \quad (4a)$$

$$H_0[\vec{\nabla} \times \vec{u}]_z = \vec{\nabla} \cdot [\vec{u} \times \vec{H}_0] \quad (4b)$$

Now taking curl of both sides of equation (1b), and noting that  $\vec{\nabla} \cdot \vec{H}$  is always zero, one obtains

$$\vec{\nabla}^2 \vec{H}_z + j\omega\epsilon_0[\vec{\nabla} \times \vec{E}]_z - eN_0[\vec{\nabla} \times \vec{u}]_z = 0 \quad (5)$$

Similarly, taking curl of both sides of equation (1c), one writes, with the help of equation (4a), the  $z$  component of the same as

$$m(j\omega + \nu)[\vec{\nabla} \times \vec{u}]_z + [\vec{\nabla} \times \vec{E}]_z - e\mu_0 H_0(\vec{\nabla} \cdot \vec{u}) = 0. \quad (6)$$

Eliminating  $[\vec{\nabla} \times \vec{u}]_z$  from equations (5) and (6), and substituting for  $[\vec{\nabla} \times \vec{E}]_z$  and  $\vec{\nabla} \cdot \vec{u}$  from equations (1a) and (1d) respectively, one obtains,

$$\vec{\nabla}^2 \vec{H}_z + \omega^2\mu_0\epsilon_0 \left\{ 1 - \frac{\omega_p^2}{\omega(\omega - j\nu)} \right\} \vec{H}_z + \frac{e\omega\omega_0}{a^2 m(\omega - j\nu)} p = 0. \quad (7)$$

Again one gets taking divergence of both sides of equation (1b),

$$\vec{\nabla} \cdot \vec{E} = \frac{eN_0}{j\omega\epsilon_0}(\vec{\nabla} \cdot \vec{u}) \quad (8)$$

and taking divergence of equation (1c) with the help of relation (4b),

$$mN_0(j\omega + \nu)(\vec{\nabla} \cdot \vec{u}) + \vec{\nabla}^2 p + eN_0\vec{\nabla} \cdot \vec{E} + eN_0 H_0[\vec{\nabla} \times \vec{u}]_z = 0 \quad (9)$$

Substituting the value of  $\nabla \cdot \vec{E}$  from equation (8) and of  $[\nabla \times \vec{u}]_z$  from equation (6), equation (9) transforms as:

$$\Delta^2 p + mN_0 \left\{ (j\omega + \nu) + \frac{\omega_p^2}{(j\omega + \nu)} + \frac{\omega_p^2}{j\omega} \right\} (\nabla \cdot \vec{u}) + eN_0 \frac{\omega_p}{(j\omega + \nu)} [\nabla \times \vec{E}]_z = 0. \quad (10)$$

Finally, putting in equation (10) for  $\nabla \cdot \vec{u}$  from equation (1d) and for  $[\nabla \times \vec{E}]_z$  from equation (1a), one obtains,

$$\nabla^2 p + \frac{\omega^2}{a^2} \left\{ \frac{(\omega - j\nu)}{\omega} - \frac{\omega_p^2}{\omega^2} - \frac{\omega_p^2}{\omega(\omega - j\nu)} \right\} p + \frac{\mu_0 N_0 \omega_p}{(\omega - j\nu)} H_z = 0. \quad (11)$$

In equations (7), (10) and (11),  $\omega p$  and  $\omega g$  are substituted for  $(N_0 e^2 / \epsilon_0 m)^{1/2}$  and  $(\mu_0 H_0 e / m)$ , the usual expressions for angular plasma and angular gyro frequencies respectively.

The wave equations (7) and (11) exhibit the coupling between electromagnetic and electroacoustic modes due to presence of static magnetic field. It is evident that in absence of the static magnetic field, the two modes become uncoupled and in collisionless plasma propagate with velocities  $c / \left(1 - \frac{\omega_p^2}{\omega^2}\right)^{1/2}$  and

$$a / \left(1 - \frac{\omega_p^2}{\omega^2}\right)^{1/2} \text{ respectively.}$$

The coupled wave equations (7) and (11) are similar to those obtained by Unz (1966) and tally with those derived by Chen and Cheng (1965) when collision frequency is neglected.

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M. R. Engineering College, S. S. RAWAT.  
Jaipur, India, December 18, 1967.

1. Unz, H., *Proc. I.E.E.E.*, 1966, **54**, 393.

2. Chen, H. H. C. and Cheng, D. K., *J. Appl. Phys.*, 1965, **36**, 3320.

### CORIOIS COUPLING COEFFICIENTS OF $CF_2C \equiv CH$ , $CF_3C \equiv CD$ AND $CF_3C \equiv CCF_3$

THE molecules  $CF_3C \equiv CH$  and  $CF_3C \equiv CD$  possess  $C_{3v}$  symmetry with  $5A_1 + 5E$  vibrations.  $CF_3C \equiv CCF_3$  has got  $D_{3d}$  symmetry with staggered configuration. For both these types of molecules, the  $\zeta$  values are evaluated for the degenerate species. The vibrational wave-numbers reported by Berney *et al.*<sup>1</sup> are

used for all the three molecules. The equilibrium values of the internuclear distances and interbond angles are given by Shoolery *et al.*<sup>2</sup> for  $CF_3C \equiv CH$  and  $CF_3C \equiv CD$  and by Sheenan and Schomaker<sup>3</sup> for  $CF_3 \equiv CCF_3$ . The Coriolis coupling coefficients  $\zeta$  are evaluated from the relation  $\zeta^a = L^{-1} C^a L^{-1}$  where  $C$  is the  $C$  matrix and  $L$ , the normal co-ordinate transformation matrix. The results are presented in Tables I and II and they obey the following sum rules<sup>4</sup>:

For  $CF_3C \equiv CH$  and  $CF_3C \equiv CD$ ,  $\sum_{i=0}^{10} \zeta_i^2 = 2 +$

$I_A/2 I_B$  and for  $CF_3C \equiv CCF_3$ ,  $\sum_{i=0}^{12} \zeta_i^2 = 1$  for the  $E_u$  species and  $\sum_{i=13}^{16} \zeta_i^2 = 1 + I_A/2 I_B$  for the  $E_g$  species.

TABLE I

Coriolis coupling coefficients of  $CF_3C \equiv CH$  and  $CF_3C \equiv CD$  for  $E \times E$  coupling

$\zeta_{ij}^a$	$CF_3C \equiv CH$	$CF_3C \equiv CD$
$\zeta_{6a, 6b}^z$	0.8494	0.8497
$\zeta_{7a, 7a}^z$	0.4955	0.4955
$\zeta_{8a, 8b}^z$	-0.8090	-0.8091
$\zeta_{9a, 9b}^z$	0.7333	0.7333
$\zeta_{10a, 10b}^z$	0.9816	0.9659
$\zeta_{6a, 7b}^z$	-0.2032	-0.2031
$\zeta_{6a, 8b}^z$	0.4547	0.4544
$\zeta_{6a, 9b}^z$	0.0738	0.0737
$\zeta_{6a, 11b}^z$	0.0194	0.0263
$\zeta_{7a, 8b}^z$	0.2936	0.2936
$\zeta_{7a, 9b}^z$	0.3305	0.3292
$\zeta_{7a, 10d}^z$	0.0873	0.1181
$\zeta_{8a, 9b}^z$	0.0963	0.0965
$\zeta_{8a, 10b}^z$	0.0254	0.0347
$\zeta_{9a, 10b}^z$	-0.0698	-0.0953

TABLE II  
Coriolis coupling coefficients of  $CF_3C \equiv CCF_3$   
for the  $E_u$  and  $E_g$  species

$E_u$ species		$E_g$ species	
$\zeta_{ij}^a$	Zeta values	$\zeta_{ij}^a$	Zeta values
$\zeta_{12}^{a, 1b}$	0.7383	$\zeta_{12}^{a, 12b}$	0.8177
$\zeta_{12}^{a, 10b}$	-0.7228	$\zeta_{12}^{a, 14b}$	-0.7865
$\zeta_{12}^{a, 11b}$	0.5218	$\zeta_{12}^{a, 15b}$	0.8409
$\zeta_{12}^{a, 13b}$	0.4579	$\zeta_{12}^{a, 16b}$	0.2202
$\zeta_{12}^{a, 14b}$	0.6128	$\zeta_{12}^{a, 17b}$	0.5630
$\zeta_{12}^{a, 15b}$	-0.1080	$\zeta_{12}^{a, 18b}$	-0.0971
$\zeta_{12}^{a, 16b}$	-0.0212	$\zeta_{12}^{a, 19b}$	-0.0471
$\zeta_{12}^{a, 17b}$	0.1422	$\zeta_{12}^{a, 20b}$	0.2338
$\zeta_{12}^{a, 18b}$	-0.0874	$\zeta_{12}^{a, 21b}$	-0.039
$\zeta_{12}^{a, 19b}$	-0.4918	$\zeta_{12}^{a, 22b}$	-0.3124

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Kerala Univ., MISS MARIAMMA P. MATHEW.  
Alwaye-4, January 30, 1968.

1. Berney, C. V., Cousins, L. R. and Miller, F. A., *Spectrochim. Acta*, 1963, 19, 2019.
2. Shoolery, J. N., Shulman, R. G., Sheenan, W. F. Jr., Schomaker, V. and Yost, D. M., *J. Chem. Phys.*, 1951, 19, 1361.
3. Sheenan, W. F., Jr. and Schomaker, V., *J. Am. Chem. Soc.*, 1952, 74, 4468.
4. Lord, R. C. and Meirfield, R. E., *J. Chem. Phys.*, 1952, 20, 1348.

### THERMAL EXPANSION OF RHODIUM

IN literature, only two reports, one by Swanger<sup>1</sup> and the other by Ebert,<sup>2</sup> on the thermal expansion of rhodium at different temperatures, using macroscopic methods, are available. There are no X-ray data on the temperature-variation of coefficient of thermal expansion. The present paper gives the values of the lattice parameter and the coefficient of expansion between 28° C. and 587° C.

Pure rhodium was used to obtain the powder pictures at different temperatures. Three reflections (331)  $a_1a_2$ , (420)  $a_1a_2$  and (422)  $a_1a_2$ , recorded at 61°, 64° and 81° Bragg angles

respectively, were used in the determination of the lattice parameter. The experimental technique and the method of evaluating the lattice parameter were the same as described earlier.<sup>3</sup> In Table I, the values of the lattice parameter at different temperatures are given.

TABLE I  
Lattice constant of rhodium at different temperatures

Temperature °C.	'a', Å
28	3.8034
170	3.8082
244	3.8113
329	3.8143
422	3.8178
512	3.8214
587	3.8248

The non-linear variation of the unit cell-dimension with temperature, as shown in Fig. 1, could be expressed by the following relation obtained by a least-squares treatment of the temperature-lattice constant data.

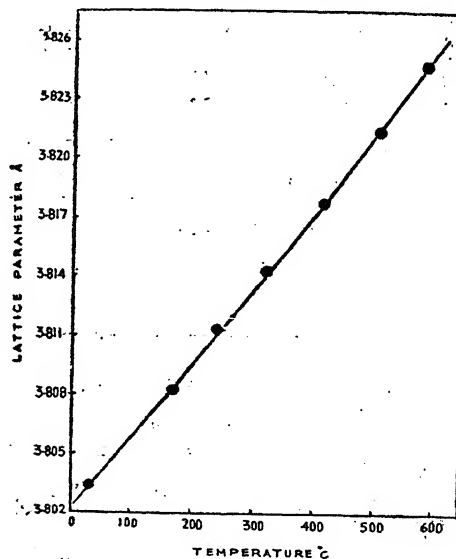


FIG. 1

$$a_t = 3.8033 + 33.43 \times 10^{-6} (t - 20) + 7.95 \times 10^{-10} (t - 20)^2.$$

The temperature dependence of the coefficient of expansion could be obtained by differentiation of the above expression, and was found to be:

$$\alpha = 8.70 \times 10^{-6} + 4.18 \times 10^{-9}t$$

Fizeau<sup>4</sup> and Owen and Yates<sup>5</sup> have reported the values of the coefficient as  $8.5 \times 10^{-6}/^\circ\text{C}$ .

(at 40° C.) and  $8.4 \times 10^{-6}/^{\circ}\text{C.}$  (at 20° C.) respectively. These values are in good agreement with the present results. Recently, while describing the working of a new high-temperature camera, Ross and Hume-Rothery<sup>6</sup> reported the values of the lattice constant at different temperatures. In Table II, the values of the coefficient of expansion of rhodium at different temperatures evaluated from the expression given above, are compared with the values calculated from the data reported by Ross and Hume-Rothery<sup>6</sup> and Ebert.<sup>2</sup> The agreement throughout the common range of temperature is found to be very good.

TABLE II  
Comparison of the thermal expansion  
coefficient of rhodium at different  
temperatures

Temperature °C.	$\alpha \times 10^6$ (Ebert <sup>2</sup> )	$\alpha \times 10^6$ (Ross and Hume-Rothery <sup>6</sup> )	$\alpha \times 10^6$ Present work
20	8.55	8.31	8.78
100	8.93	8.67	9.12
200	9.40	9.11	9.54
300	9.87	9.55	9.95
400	10.34	9.99	10.37
500	10.81	10.43	10.80
600	11.27	10.88	11.21

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1. Swanger, W. H., *J. Res. Natl. Bur. Stand.*, 1929, **B3**, 1039.
2. Ebert, H., *Z. Phys.*, 1938, **39**, 6.
3. Deshpande, V. P. and Pawar, R. R., *Curr. Sci.*, 1962, **31**, 497.
4. Fizeau, H., *C.R. Acad. Sci.*, 1869, **68**, 1125.
5. Owen, E. A. and Yates, E. L., *Phil Mag.*, 1933, **15**, 472.
6. Ross, K. G. and Hume-Rothery, W., *J. Less Common Met.*, 1963, **5**, 258.

## MANGANESE (II) COMPLEXES WITH 2-METHYL QUINOLINE

MANY hexa-co-ordinated<sup>1</sup> and tetra-co-ordinated<sup>2</sup> compounds of manganese (II) were reported in the literature. As a part of our investigations on nitrogen-bonded metal complexes, we had earlier reported<sup>3</sup> several divalent manganese complexes with quinoline and isoquinoline. This communication describes

some more complexes using 2-methyl quinoline as a ligand (L).

To an ethanoic solution of manganous halide  $\text{MnX}_2$  ( $\text{X} = \text{Cl}^-, \text{Br}^-, \text{I}^-$ ), the ligand was added in 1 : 2 ratio. There was an immediate separation of the compounds which were filtered, washed with ethanol followed by petroleum ether and dried *in vacuo*. These compounds, on analysis, corresponded to the composition  $\text{MnLCl}_2$ ,  $\text{MnL}_2\text{Br}_2$  and  $\text{MnL}_3\text{I}_2$ . Instead of separating the compounds in cold, if the mixture of the reactants was refluxed for 3 hours, cooled and then the compounds were isolated, they corresponded to  $\text{MnL}_2\text{Cl}_2$ ,  $\text{MnL}_2\text{Br}_2$  and  $\text{MnL}_2\text{I}_2$ . Thermal decomposition studies reveal that at 130° C.,  $\text{MnL}_2\text{Cl}_2$  and  $\text{MnL}_2\text{Br}_2$  lose weight corresponding to the loss of one molecule of 2-methyl quinoline. The dirty white, amorphous compounds obtained on decomposition were washed with ethanol and petroleum ether and dried. They corresponded to the composition  $\text{MnLCl}_2$  and  $\text{MnLBr}_2$ . The compound  $\text{MnL}_3\text{I}_2$  did not however lose any weight at 130° C.

All the compounds do not melt upto 280° C. They are sparingly soluble in acetone in which medium they are essentially non-electrolytes (Table I) since the molar conductance,  $\Lambda_m$  for 1 : 1 electrolytes is round about 150 mhos. Magnetic susceptibility measurements carried at 25° C. on solid specimens using Gouy method indicate that they are paramagnetic with 5 unpaired electrons. The analytical, conductance and magnetic data are recorded in Table I.

The infrared spectra of these complexes as Nujol mulls were recorded using Unicam SP 200 spectrophotometer. The absorption bands of the free ligand and the complexes are recorded in Table II.

The shifting and/or splitting of ligand absorption bands are as expected consequent to the metal-ligand bonding since the ligand is not free but bonded to the metal.

We had earlier shown<sup>3</sup> that  $\text{Mn}(\text{IQ})_2\text{Cl}_2$  and  $\text{Mn}(\text{IQ})_2\text{Br}_2$  are not monomers but octahedral polymers. The compounds reported now having the formulæ  $\text{MnL}_2\text{X}_2$  and  $\text{MnL}_3\text{X}_2$  are sparingly soluble in acetone and have high melting points indicative of polymerisation to increase the co-ordination number to 6. The compounds having the formula  $\text{MnLX}_2$  are also polymeric and they are similar to manganese (II) compounds reported<sup>4</sup> by us earlier with substituted pyridines. They are presumably tetrahedral polymers. Both the tetrahedral and octahedral structures are compatible with the magnetic

TABLE I  
Analysis, conductance and magnetic moments of manganese (II) complexes with 2-methyl  
Quinoline

Complex (L=2-Methyl quinoline)	% Manganese		% Halogen		$\Delta_M$ (mhos) in acetone	$\mu_{eff.}$ (B.M.)
	Found	Calcd.	Found	Calcd.		
MnLCl <sub>2</sub>	20.3	20.5	26.1	26.4	25.0	6.0
MnLCl <sub>2</sub>	13.1	13.4	17.1	17.2	26.7	6.1
MnLBr <sub>2</sub>	10.5	10.9	31.7	31.9	28.6	6.1
MnLBr <sub>2</sub>	15.1	15.4	44.4	44.7	27.5	5.8
MnI <sub>2</sub>	7.4	7.5	34.2	34.4	30.4	5.8
MnL <sub>2</sub> I <sub>2</sub>	9.0	9.2	42.3	42.7	33.0	5.9

TABLE II  
Infrared spectra of manganese (II) complexes with 2-methyl quinoline (cm.<sup>-1</sup>)

2-methyl quinoline (L)	MnLCl <sub>2</sub>	MnL <sub>2</sub> Cl <sub>2</sub>	MnL <sub>2</sub> Br <sub>2</sub>	MnLBr <sub>2</sub>	MnL <sub>2</sub> I <sub>2</sub>	MnL <sub>2</sub> I <sub>2</sub>
762 (s)	725 (w)	725 (w)	730 (sh)	..	730 (sh)	720 (m)
..	710 (vs)	742 (vs)	742 (vs)	740 (vs)	744 (vs)	740 (s)
..	780 (s)	780 (s)	780 (s)	..	782 (s)	780 (sh)
820 (vs)	820 (s)	810 (s)	810 (s)	820 (sh)	810 (s)	820 (w)
..	840 (vs)	838 (vs)	836 (vs)	835 (vs)	840 (vs)	836 (s)
..	..	845 (s)	842 (sh)	..	850 (s)	..
..	875 (s)	878 (vs)	878 (vs)	862 (vs)	880 (vs)	865 (s)
970 (w)	950 (s)	940 (w)	..	940 (w)	940 (w)	..
990 (w)	970 (s)	968 (s)	970 (s)	960 (s)	970 (s)	960 (br)
1030 (w)	1025 (m)	1026 (m)	1025 (m)	..	1028 (m)	..
1050 (w)	1050 (s)	1045 (s)	1045 (s)	1042 (s)	1048 (vs)	1042 (s)
1230 (s)	1150 (s)	1150 (w)	1150 (w)	..	1160 (br)	1160 (br)
..	1220 (s)	1220 (s)	1220 (s)	..	1220 (s)	1220 (w)
..	1280 (vs)	1280 (s)	1280 (vs)	1280 (s)	1280 (vs)	1280 (w)
1325 (s)	—	—	—	—	—	—
1390 (s)	—	—	—	—	—	—
1440 (s)	—	—	—	—	—	—
1520 (s)	1502 (s)	1505 (s)	1510 (vs)	..	1510 (s)	..
1615 (s)	1595 (m)	1600 (s)	1601 (s)	1600 (w)	1600 (s)	1600 (sh)
1632 (w)	1625 (vs)	1630 (vs)	1632 (vs)	1630 (vs)	1632 (vs)	1630 (s)

s—sharp, vs—very sharp, w—weak, m—medium, sh—shoulder, br—broad, — means overlap of Nujol peaks.

data of 5 unpaired electrons (3d<sup>5</sup> spin-free) involving the use of either 4s4p<sup>3</sup> or 4s4p<sup>3</sup>4d<sup>2</sup> hybrid orbitals for bonding.

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### PARACHARNOKITES FROM ANANTAGIRI, EASTERN GHATS, ANDHRA PRADESH

THE rock formations at Anantagiri, Eastern Ghats (Lat. 83° 30' and Long. 18° 14' 2") essentially consist of khondalite suite, charnockitic suite — pyroxene-amphibole-garnet-biotite-assemblages, pegmatites, quartz veins and gneisses of granitic composition of Archæan age.

The acid and intermediate types of the charnockitic rocks form a unit between the garnet-biotite gneisses and the garnet-biotite-sillimanite gneisses. The banding seen on the fresh surfaces persists on the weathered rocks also. The alternate bands show concentrations

1. Goldenburg, N., *Trans. Farad Soc.*, 1940, **36**, 847.
2. Gill, N. S., Nyholm, R. S. and Pauling, P., *Nature*, 1958, **182**, 168.
3. Dash, K. C. and Ramana Rao, D. V., *Indian J. Chem.*, 1967, **5**, 333.
4. Guru, S., Dash, K. C. and Ramana Rao, D. V., *Ibid.*, (In press).



of mafic and felsic minerals. These rocks in association with garnet-biotite gneisses and quartzites have gradational contact zones. The garnet-hypersthene-granulites and garnetiferous quartzites are observed in these zones. No intrusive contact is observed among the major rock units. At certain places concentration of hypersthene and garnets into knots is observed. Microscopically there is an intergrowth between the hypersthene and garnet. With an increase in garnet content, the hypersthene is found to decrease in amount and the rock grades within a limited exposure into garnetiferous granulite.

Microscopic texture is granoblastic but most sections revealed lineation. Parallel arrange-

ment is observed among the melanocratic constituents (hypersthene, hornblende, diopside and biotite) which occur as streaks and parallel bands alternating with wider leucocratic ones composed mostly of quartz, potash feldspar, twinned and untwinned plagioclase of the oligoclase-andesine variety. Micropegmatic and myrmekitic inter-growths between orthoclase and quartz, and plagioclase and quartz are very common and show optical continuity.

The chemical data (Tables I a and b) have been processed through a number of petrochemical calculations and diagrammatic representations (Osann, Becke, Niggli, Köhler and Razz, Brämml, Niggli-Becke and others). The plots of these rocks, have similar disposition as

TABLE I a  
Chemical analysis of paracharnockites (Wet and rapid methods)

	Hypersthene granulite		Hypersthene-diopside granulite	
	Quartz Alkali-feldspar-Plagioclase-Hypersthene ± Garnet and Biotite		Quartz Alkali-feldspar-Plagioclase-Hypersthene-Diopside-Hornblende ± Garnet and Biotite	
	1	2	3	4
SiO <sub>2</sub>	69.51	70.74	60.42	64.51
TiO <sub>2</sub>	0.14	0.40	0.32	0.78
Al <sub>2</sub> O <sub>3</sub>	14.06	12.13	15.60	15.02
Fe <sub>2</sub> O <sub>3</sub>	0.49	2.50	2.90	2.78
FeO	3.96	1.70	8.80	4.78
MnO	0.04	0.05	0.03	0.15
MgO	1.02	1.20	2.43	2.01
CaO	2.92	3.30	5.46	5.39
Na <sub>2</sub> O	2.26	4.90	1.63	3.19
K <sub>2</sub> O	5.08	1.90	1.86	1.27
P <sub>2</sub> O <sub>5</sub>	0.33	0.20	0.43	0.24
H <sub>2</sub> O	0.62	0.50	0.83	0.37
Total	100.43	99.52	100.13	100.49
X <sub>2</sub>	-9.9	-8.99	-8.04	-5.88

TABLE I b  
Trace elements in paracharnockites (X-Ray Fluorescence and Spectrographic Techniques)

	Hypersthene-granulites		Hypersthene-diopside-granulites	
	1	2	3	4
Co	45	34	25	30
Cr	230	340	80	150
Ni	60	52	27	48
Cu	130	160	115	300
V	35	95	17	22
Y	15	18	Sp.	8
Sc	48	55	7	40
Mn	1,200	1,300	1,300	1,150
Ba	1,100	2,750	300	870
Zr	90	98	130	75
Ag	2.5	2	0	..
Sr	208	215	34	146
Rb	17	10	10	35

the khondalitic rocks which are of undoubted sedimentary origin. Discriminant function  $X_3$  (Table I a) (Shaw and Kudo, 1965) is calculated and these rocks, along with the khondalites, have recorded negative values indicating their *para* nature.

The grade of metamorphism of these rocks as determined from their mineral assemblage and plot on ACF diagrams is that of pyroxene granulite sub-facies of granulite facies of regional metamorphism.

The rock types in their outward physical description as well as the mineral composition are charnockites (acid and intermediate) (Holland, 1900). Chemical and field evidence suggests a sedimentary parentage for these rocks and as such they are classified as *paracharnockites* (Parras, 1958).

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Waltair, December 20, 1967.

1. Parras, K., *Bulletin De La Commission, Geologique De Finlande*, 1958, p. 181.
2. Pichamuthu C. S., *The Charnockite Problem*, 1953.
3. Shaw, D. M. and Kudo, A. M., *Mineralogical Magazine*, London, 1965, 34, 268, 423.

### CLEAVAGE AND OXIDATION OF PHOSPHORUS-SULPHUR BONDS BY CHLORAMINE-T

RECENTLY, two instances of the rupture and oxidation of P-S bonds by Chloramine-T have been reported.<sup>1,2</sup> It is now well known that Chloramine-T can effect the cleavage and oxidation of C-S, N-S, S-S and H-S bonds.<sup>3-12</sup> In order to examine further the behaviour of P-S bonds towards Chloramine-T, we studied the oxidation of phosphorus pentasulphide,  $P_2S_5$ , by this oxidant. The results are reported and general conditions for the oxidimetric determination of P-S compounds by Chloramine-T are outlined in this communication.

**Reagents:** Merck Guaranteed Reagent  $P_2S_5$  as employed. Approximately 0.05 M solutions of  $P_2S_5$  were prepared in 1N aqueous sodium hydroxide. These solutions were standardized by subjecting aliquots to elemental analysis for sulphur.<sup>13</sup> Stock solutions of Chloramine-T were prepared, standardised by

the method of Bishop and Jennings<sup>14</sup> and stored in amber-coloured bottles.

**Procedure:** Preliminary experiments showed that oxidation by Chloramine-T in acidic medium led to partial precipitation of elemental sulphur. Hence complete oxidation of the entire sulphur in  $P_2S_5$  to the sulphate ion was achieved by carrying out the oxidation in alkaline medium. Aliquots (4 to 6 ml.) of the  $P_2S_5$  solutions were added to excess (100 to 150 ml.) of standard, decinormal aqueous Chloramine-T solution alkalified with 1N sodium hydroxide solution (40 to 60 ml.). The mixtures were kept aside at room temperature (+ 28° C.) for about 30 minutes. The mixtures were then acidified with 5N sulphuric acid (40 to 60 ml.) and the unconsumed oxidant was determined iodometrically with standard thiosulphate. Blank experiments, done concurrently, showed that no blank corrections were necessary.

In order to ascertain whether the oxidation is completed in the alkaline medium itself, a second series of experiments were carried out, in which the unconsumed Chloramine-T was estimated in the alkaline medium by adding a known volume (excess) of standard arsenite solution and by titrating the unconsumed arsenite, in a bicarbonate buffer, in presence of starch and a crystal of potassium iodide, with standard Chloramine-T solution, to a permanent pale-blue end-point.<sup>14</sup>

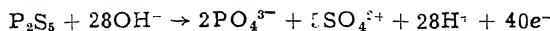
The results of typical experiments are indicated in Table I.

TABLE I

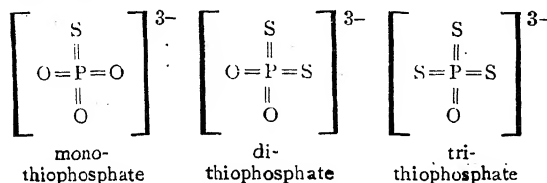
Experiment Number	Millimoles $P_2S_5$ taken	Milliequivalents Chloramine-T consumed	Number of equivalents of Oxidant consumed per mole of $P_2S_5$
1	0.0966	3.870	40.05
2	0.1450	5.830	40.21
3	0.2410	9.638	39.89
4	0.3382	13.550	40.05
5	0.0563	2.236	39.72
6	0.1126	4.535	40.28

In experiments 5 and 6, the unconsumed Chloramine-T was determined in the alkaline medium, whereas in the remaining experiments, the determination of the unconsumed Chloramine-T was carried out after acidification.

It may be seen from the analytical results that 40 equivalents of oxidant are consumed per mole of  $P_2S_5$ . This agrees with the following oxidation scheme:



$P_2S_5$  undergoes conversion into a mixture of mono-, di- and tri-thiophosphate ions in alkaline solutions.<sup>15</sup> These ions have the formulæ



All the P-S bonds in these ions are therefore ruptured and the entire sulphur oxidised by Chloramine-T into the sulphate ion.

In conclusion, it may be noted that in our previous publication<sup>1</sup> on the oxidation of trisodium phosphorothioate (monothiophosphate) by Chloramine-T, we recommended carrying out the oxidation in an acidic medium, right from the start. This is not feasible with  $P_2S_5$  due to the precipitation of elemental sulphur on acidification; hence the preference for an alkaline medium here. We may therefore outline the following conditions for the oxidimetric estimation of PS compounds by Chloramine-T.

1. If the PS compound does not liberate elemental sulphur on acidification, the oxidation is best carried out in an acidic medium. An acidic medium is to be preferred to an alkaline one, in the absence of other conditions, because the redox potential of Chloramine-T increases with decreasing pH.<sup>16</sup> The oxidations employing an acidic medium are usually complete in less than two minutes.

2. If the PS compound precipitates elemental sulphur on acidification (as is often the case with sulphur-rich PS compounds with several S atoms attached to P), an alkaline medium has to be employed to avoid the precipitation of elemental sulphur (which resists oxidation by Chloramine-T). In this case the time needed for complete oxidation has to be ascertained for each compound.

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University of Kerala,  
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1. Jose Jacob, T. and Nair, C. G. R., *Ind. J. Chem.*, 1966, **4**, 501.
2. Iaxminarayana, V. and Murthy, A. R. V., *Chem. Anal.*, 1965, **54**, 9.
3. Jose Jacob, T. and Nair, C. G. R., *Curr. Sci.*, 1966, **35**, 334.
4. — and —, *Ibid.*, 1967, **36**, 126.
5. — and —, *Talanta*, 1966, **13**, 154.
6. Rao, V. R. S. and Murthy, A. R. V., *Ibid.*, 1960, **4**, 206.
7. Nair, C. G. R. and Murthy, A. R. V., *Chem. & Ind., London*, 1962, p. 1539.
8. — and —, *Monatsh. Für Chem.*, 1963, **94**, 134.
9. — and —, *J. Sci. & Ind. Res., India*, 1962, **21B**, 147.
10. —, Joseph, T. and Joseph, P. T., *Chem. Anal.*, 1965, **54**, 111.
11. Murthy, A. R. V., *Curr. Sci.*, 1953, **22**, 342.
12. Mahadevappa, D. S., *Ibid.*, 1965, **34**, 530.
13. Treadwell, F. P. and Hall, W. T., *Analytical Chemistry* John Wiley, New York, 1958, **2**, 314.
14. Bishop, E. and Jennings, V. J., *Talanta*, 1958, **1**, 197.
15. Brauer, G., *Handbook of Preparative Inorganic Chemistry*, Academic Press, New York, 1963, **1**, 589.
16. Murthy, A. R. V. and Rao, B. S., *Proc. Ind. Acad. Sci.*, 1952, **35**, 69.

# COUPLING REACTION WITH 1-PHENYL-2-HYDROXY-4-(4'-METHOXY- PHENYL)-6-PYRIDONE: FORMATION OF 1-PHENYL-2:3:6-TRIKETO- 3-ARYLHYDRAZONE-4-(4'-METHOXY- PHENYL) PYRIDINES

THE coupling of 4-methoxybenzenediazonium chloride with 1-methyl-3-hydroxy-5-pyrazolone imide has been shown to yield 1-methyl-3-hydroxy-4-(4'-methoxyphenylazo)-5-pyrazolone imide.<sup>1</sup> We wish to report similar condensation of various aryldiazonium chlorides with 1-phenyl-2-hydroxy-4-(4'-methoxyphenyl)-6-pyridone<sup>2</sup> leading to the formation of coloured products which were assigned 1-phenyl-2:3:6-triketo-3-arylhydrazone-4-(4'-methoxyphenyl)-pyridine structure (I) in

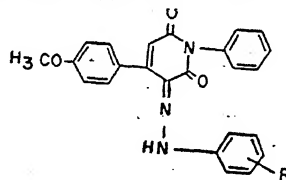
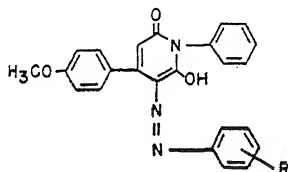


TABLE I

Sl. No.	R	Colour	m.p. °C.	Yield %	Molecular formula	Analysis % nitrogen	
						Calcd.	Found
1	H	Bright yellow	245-247	57	$C_{24}H_{19}N_3O_3$	10.58	10.66
2	1-CH <sub>3</sub>	Yellow	270-231	51	$C_{25}H_{21}N_3O_3$	10.22	10.08
3	2-OCH <sub>3</sub>	Pale yellow	286-288	59	$C_{25}H_{21}N_3O_4$	9.83	9.56
4	4-OCH <sub>3</sub>	Yellow	22-224	68	$C_{25}H_{21}N_3O_4$	9.83	9.92
5	2-NO <sub>2</sub>	Deep yellow	213-215	60	$C_{24}H_{18}N_4O_5$	12.67	12.42
6	3-NO <sub>2</sub>	Greenish-yellow	210-212	64	$C_{24}H_{18}N_4O_5$	12.67	12.47
7	4-NO <sub>2</sub>	Yellow	218-220	72	$C_{24}H_{18}N_4O_5$	12.67	12.62
8	2-Cl	Pale yellow	287-289	55	$C_{24}H_{18}ClN_3O_3$	9.75	9.79
9	3-Cl	Orange	270-232	62	$C_{24}H_{18}ClN_3O_3$	9.75	9.58
10	4-Cl	Yellow	224-226	68	$C_{24}H_{18}ClN_3O_3$	9.75	9.58
11	4-Br	Yellow	233-234	63	$C_{24}H_{18}BrN_3O_3$	8.82	8.55

All compounds gave satisfactory carbon and hydrogen percentage.

preference to azo tautomer (II) on the basis of negative ferric chloride colouration test and I.R. spectral investigation.



II.

To a stirring solution of pyridone (0.01 mole) in sodium carbonate (20 ml.—8%) was added aqueous aryldiazonium chloride (0.01 mole) dropwise while the temperature was maintained at 15-20°. The reaction mixture was then left at room temperature for about two hours. The solid thus separated was collected and crystallized from suitable solvent.

These compounds ranged from yellow to orange in colour and their yields varied from 51-72%. Furthermore, the pyridine ring of I was found very resistant to opening even by prolonged boiling with strong mineral acids or alkalis. The data characterizing these condensation products (I) are summarized in Table I.

Acknowledgement is gratefully made to Ramnarain Ruia College authorities for placing the laboratory facilities at our disposal.

Dept. of Chemistry, A. D. PALEKAR.  
Ramnarain Ruia College, R. A. KULKARNI.  
Mumbai-19, December 21, 1967.

- Graham, B., Porter, H. D. and Weibserger, A. *J. Am. Chem. Soc.*, 1949, **71**, 983.
- Bhave, V. M., *J. Ind. Chem. Soc.*, 1931, **8**, 137.

#### EFFECT OF CASTRATION AND REPLACEMENT THERAPY ON SUBCELLULAR DISTRIBUTION OF ZINC IN RHESUS MONKEY PROSTATE

THE presence of considerable quantities of zinc in the prostate gland of different species of animals and man has been well documented.<sup>1,2</sup> In rat the concentration of zinc in the dorso-lateral prostate is about 10 times higher than that of any other tissues<sup>1</sup>; the uptake of Zn<sup>65</sup> by this lobe is also 15 to 20 times greater than other tissues.<sup>3</sup> Ultracentrifugation studies on rat and rhesus monkey prostate have shown that the metal is present in the particulate and non-particulate fractions, with the highest concentration in the nuclear sediment.<sup>4</sup> Autoradiographic investigations have revealed that Zn<sup>65</sup> is accumulated in the acinar epithelium and the secretions.<sup>5</sup> Prostatic zinc concentration is under androgenic regulation of the testis.<sup>6-8</sup> The present communication deals with the effect of castration and replacement therapy on subcellular distribution pattern of zinc in the rhesus monkey (*Macaca mulatta*) prostate.

Adult rhesus monkeys (9-11 kg.) of the Institute primate colony were used in this investigation. They were maintained under uniform husbandry conditions throughout the experimental period. The castrated animals were given a rest period of 30 days before commencement of hormone therapy. The dose of testosterone propionate (TP) was 2 mg. (in 2 ml. sterile olive oil) daily per monkey by the intramuscular route for 21 days. The intact controls and castrated animals received the solvent alone in a similar manner. The methods of isolation of subcellular fractions of the prostate, estimation of zinc by polarography,

TABLE I

Distribution of zinc in the subcellular fractions of the rhesus monkey prostate

Fraction*	Controls				Castrated				Castrated + TP			
	Total nitrogen		Zinc content		Total nitrogen		Zinc content		Total nitrogen		Zinc content	
	Mg./gm.	% of homogenate	Mg./gm.	% of homogenate	Mg./gm.	% of homogenate	Mg./gm.	% of homogenate	Mg./gm.	% of homogenate	Mg./gm.	% of homogenate
Homogenate	20.4	..	2.8	..	18.7	..	2.0	..	19.6	..	2.7	..
Nucleus	4.3	29.2	2.8	46.2	4.0	27.6	1.9	36.0	4.2	23.9	2.8	44.0
Mitochondria	3.5	27.4	0.5	20.1	3.2	25.1	0.4	14.0	3.4	27.1	0.5	18.1
Microsome	2.5	12.3	1.0	9.4	2.3	12.0	0.6	5.0	2.5	12.2	1.0	8.9
Supernatant	5.7	24.3	2.1	30.4	5.4	23.9	1.5	20.0	5.6	24.2	2.2	27.6

\* Data based on pooled samples of prostate from 3 monkeys; each value represents mean of 3 estimations.

and determination of nitrogen were the same as described previously.<sup>4</sup>

It will be evident from the results presented in Table I that castration caused a consistent reduction in zinc content from all fractions of the prostate. On mg./gm. nitrogen basis the maximal decrease was seen in the nuclear sediment (32%). TP therapy restored the zinc concentration of all the fractions to virtually normal values. It was interesting that castration and replacement therapy did not alter the pattern of distribution of the metal, since, as in controls, the nuclear sediment continued to show the highest concentration followed by the supernatant, microsome and the mitochondrial fractions in diminishing order.

Apparently, androgen regulates the concentration of zinc in the subcellular fractions of the prostate without altering its qualitative distribution.

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Central Drug Res. Inst., A. R. CHOWDHURY.  
Lucknow (Communication AMYA B. KAR.

No. 1245), January 30, 1968.

1. Mawson, C. A. and Fischer, M. I., *Nature*, London, 1951, **167**, 859.
2. — and —, *Biochem. J.*, 1953, **55**, 693.
3. Gunn, S. A., Gould, T. C. and Ginori, S. S., *Proc. Soc. Exp. Biol. Med.*, 1955, **88**, 556.
4. Kar, A. B. and Chowdhury, A. R., *J. Urol.*, 1966, **96**, 370.
5. Mawson, C. A. and Fischer, M. I., *Proc. Second Int. Congr. Biochem.*, Paris, 1962, p. 145.
6. Kar, A. B., Pover, W. F. R. and Boscott, R. J., *Acta Endocrinol.*, 1956, **22**, 390.
7. Gunn, S. A. and Gould, T. C., *Endocrinol.*, 1956, **58**, 443.
8. Kar, A. B., Chowdhury, S. R., Chowdhury, A. R., Kamboj, V. P. and Chandra, H., *Steroids*, 1965, **5**, 513.

### INFLUENCE OF HAEMOGLOBIN VARIANT ON THE FERTILITY IN BIKANERI (MAGRA) SHEEP

IN sheep two variants of haemoglobin (Hb) have been reported.<sup>1,2</sup> No studies have been carried out in this country on the relationship of Hb variants with economic characters of the sheep. A study was undertaken on the Hb typing of Bikaneri (Magra) sheep which also involved the breeding of ewes and rams carrying similar Hb variant to observe its effect on fertility.

For the determination of haemoglobin variants, paper-electrophoresis studies were conducted using the tris Borate buffer (pH 9.2). The electrophoresis was allowed at 150 V for 16 hours. It was observed that in a population of 205 sheep, 4.68% belonged to Hb A, 65.06% to Hb B and 30.26% to Hb AB. One hundred and eighteen ewes were used for carrying out fertility trial telescoped to a period of 30 days. The results of the breeding operation on the basis of actual lambing are given in Table I.

TABLE I

Hb type		Flock strength bred	Number of ewes lambled	Fertility per cent.
Ewe	Ram			
A	A	8	4	50.00
B	B	68	45	66.17
AB	AB	38	30	78.90

The preliminary study indicates that of the homozygous sheep, higher fertility is associated with Hb B, while fertility was highest in the heterozygous. As the haemoglobin type of the animal is a gene controlled characteristic, it appears that breeding of animals according to the Hb variant would prove to be of great applied value in view of the possibility to

fix the physiological traits through controlled breeding programme. Studies on the correlation between Hb type and certain economic characteristic (fertility, growth and fleece weight) are in progress.

My thanks are due to Dr. A. Roy for guidance.

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Mathura (India), January 15, 1968.

O. N. SETH.

1. Harris, H. and Warren, F. L. *Biochem. J.*, 1955, **60**, 29.
2. Evans, J. V., King, J. W. B., Cohen, B. L., Harris, H. and Warren, F. L., *Nature*, 1956, **178**, 849.

### ON BLACK SAND CONCENTRATES

THE voluminous black sand concentrates (BSC) in beach sands along the East and West coasts of India, in a series of local concentrations, at favourable localities, constitute a thorium asset of world importance. The geological occurrences of the minerals of the BSC are usually found in granites, gneisses, pegmatites and such other rock types of crystalline complex of Archæan age, which occur between the projected base of the Deccan Traps and the present land surface. These accumulations of economically important heavy minerals, some of which are radioactive, have been formed by destruction of the pre-existing rocks and are carried away by running water, ultimately joining the beach sands so that they are sporadically distributed. After repeated sorting by the action of running water, wave, tide or wind, the heavy black sands along with the radioactive resistates are separated at some favourable localities forming beach placers. As they were thus the predominant constituents of phaneritic crystalline source rocks, they are the stable primary detritals in sand size.

However, the fractionation by mechanical separation is commonly imperfect and hence there will be a gradation in grain size with a corresponding gradation in both chemical and mineralogical composition, which is expected to be reflected in distribution of radioactivity in different fractions of BSC. In order to elucidate this, the BSC collected from Nagerkoi, Madras State, has been chosen. The  $\beta$ -activity of different naturally-occurring fractions of the BSC, which have been made free

from magnetic material, has been determined with a Geiger-Muller Counting System (supplied by the Atomic Energy Establishment, Trombay), consisting of Utility Scaler (Type DS 4110, Preset Timer Type ET 450), and the Geiger-Muller tube (Type I 1030) which is of end-window type with a wall thickness of 3 mg./cm.<sup>2</sup> and operating voltage of 1,275 V. The percentage of equivalent  $U_3O_8$  of each sample has been determined from the  $\beta$ -activity index, by calibrating the G.M. counting system with NBL standard sample of pitch blende mixed with dunite, following the method of Nininger (1956). The results are tabulated in Table I.

TABLE I

Serial No.	Grain size in microns	Counts per minute	Radioactivity ( $\beta$ -activity) per cent. $U_3O_8$ $\epsilon/g$
1	500-231	50	0.0024
2	231-178	92	0.0044
3	178-152	113	0.0049
4	152-124	152	0.0073
5	124-89	874	0.0417
6	89-76	993	0.0474

From Table I it is clear that the same sample of BSC does not have a uniform value of  $\beta$ -activity but shows, very strikingly, a progressive increase towards finer-sized fractions indicating that the radioactivity increases with the decrease in grain size. As might be expected from a study of the relation between the grain size of sediments and their chemical and mineralogical composition, a close correlation between grain size and radioactivity has been established in the present study. The BSC, which is a product of large-scale chemical and mechanical fractionation processes, is in fact concentrate, sharply contrasted with respect to the distribution of radioactivity in different size fractions.

Grateful thanks are due to Prof. M. G. Chakrapani Naidu for many helpful suggestions.

Dept. of Geology, E. A. V. PRASAD.  
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Tirupati (A.P.), December 16, 1967.

1. Nininger, R. D., *Minerals for Atomic Energy*, D. Van Nostrand Co., Inc., Princeton, New Jersey, 1956, p. 194.

# FOSSIL WOOD OF *TERMINALIA* FROM KUTCH

THE fossil wood recorded here was collected from near Rutnal (23° 13' N.; 24° 53' E.), a small railway station on Gandhidham-Bhuj branch line of the Western Railway. It appears to have been derived from the Intertrappean beds, whose outcrops in this area have been obscured by denudation (Wynne, 1872). It shows striking resemblance in all the observed

anatomical details to the fossil wood of *Terminalia tomentosa* first described by Chowdhury and Tandon (1964), from the Tertiary of Burma.

The fossil wood is represented by a small piece of decorticated secondary xylem and shows the following characters: Wood diffuse-porous. Growth rings present, delimited by smaller vessels and initial or terminal parenchyma (Fig. 1). Vessels circular to oval, mostly medium-sized, t.d. 90-225  $\mu$ , r.d. 120-255  $\mu$ , usually solitary, often in radial multiples of 2-3 cells, 3-7 per sq. mm.; vessel-members 225-405  $\mu$  long. Parenchyma vasicentric to usually aliform, sometimes confluent and terminal or initial at the growth rings. Xylem rays mostly uniseriate, rarely biseriate, 20-40  $\mu$  broad and 5-27 cells and 75-520  $\mu$  high, 12-15 per mm.; ray tissue appears to be homogeneous composed of procumbent cells. Fibres polygonal in cross-section, 8-12  $\mu$  in diameter, moderately thick-walled with large lumina; presence or absence of septa could not be ascertained due to poor preservation.

*Terminalia tomentosa*, the nearest ally of the present fossil wood, is one of the commonest and most widely distributed Indian forest trees. Fossil woods showing close resemblance with this modern species are known from the Decan Intertrappean series of Gujarat (Mahabale and Deshpande, 1965), the Middle Miocene of Nagaland (Prakash, 1966) and the Late Tertiary of Burma (Chowdhury and Tandon, 1964).

Thanks are due to Dr. S. K. Roy for collecting the fossil and placing it at the disposal of the authors for investigation.

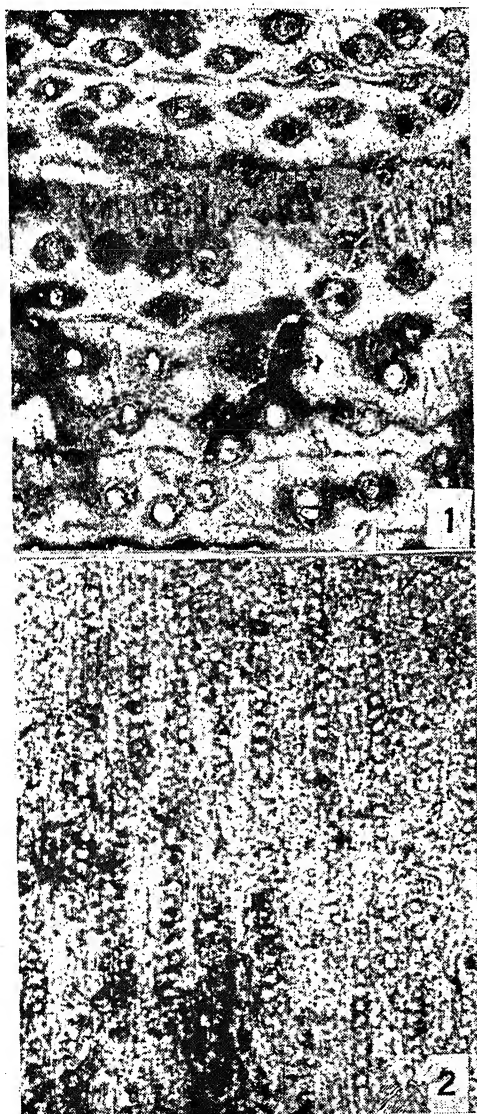
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Lucknow, January 15, 1968.

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1. Chowdhury, K. A. and Tandon, K. N., *Ann. Bot. Lond.*, N.S., 1964, 28 (11), 445.
2. Mahabale, T. S. and Deshpande, S. R., *Bull. Bot. Surv. India*, 1965, 7 (14), 267.
3. Prakash, U., *Centre Ad. St. Geol. Punjab Univ Chandigarh Pub.*, 1966, 3, 27.
4. Wynne, A. B., *Mem. Geol. Surv. India*, 1872, 9 (2) 116.



FIGS. 1-2. Fig. 1. Cross-section of the fossil wood in low power,  $\times 15$ . Note the vessel and parenchyma distribution. Fig. 2. Tangential section showing xylem rays,  $\times 100$ .

OBSERVATIONS ON THE  
PENETRATION GLAND IN THE  
ONCOSPHERE OF *OCHORISTICA*  
*INDICA* MISRA (CESTODA:  
CYCLOPHYLLIDEA)

IN cestodes the oncosphere is the first stage larva which must penetrate the gut-wall of the intermediate host (vertebrate or invertebrate) to reach a favourable site for further development. Among cyclophyllidean oncospheres it has been documented that invasion of the gut-wall of the intermediate host is accomplished through the involvement of the secretion of penetration glands present in the larvæ. In this connection the hexacanth of the linstowiine anoplocephalids *Ochoristica deserti* and *O. symmetrica* have been studied by Millemann<sup>1</sup> and Ogren<sup>2</sup> respectively.

Recently Rybicka<sup>3</sup> has reviewed our present knowledge of the occurrence, nature and functional significance of the penetration glands. It is apparent that there exist certain differences in the distribution and anatomy of the glands in the oncospheres of different cestode species. For instance in *O. symmetrica* the gland is described by Ogren as a roughly 'C'-shaped granular organ with no pores leading to the outside. The secretion seems to diffuse out through the surface of the larva. But in *O. deserti* the structure of the gland conforms to a more generalised and widespread configuration known in many oncospheres, namely, a U-shaped binucleate mass with openings lateral to the median pair of hooks.

In our studies on *O. indica* it is revealed that the structure of the gland resembles that of *O. deserti*. Actually it is composed of broader areas (anterolateral to the origin of the hooks) passing posteriorly as narrower parts and opening by minute pores situated on each side between lateral and median pairs of hooks respectively (Fig. 1).

A precise and elaborate information regarding the histochemistry of the secretion of the penetration gland in the oncospheres of various cyclophyllidean cestodes is wanting. The only comprehensive investigations on the subject are those of Ogren, Sawada and Silverman. Ogren points out that the secretion of penetration gland in *O. symmetrica* is a protein (probably scleroprotein). Sawada<sup>4</sup> and Silverman<sup>5</sup> reported the presence of polysaccharide complexes in the penetration gland of *Raillietina cesticillus* and *Tænia pisiformis* respectively.

The penetration gland in *O. indica* can be made out vividly with some histological stains. It gives a deep blue colour with Heidenhain's azan and deep purple with the chrome hæmatoxylin-phloxine method.

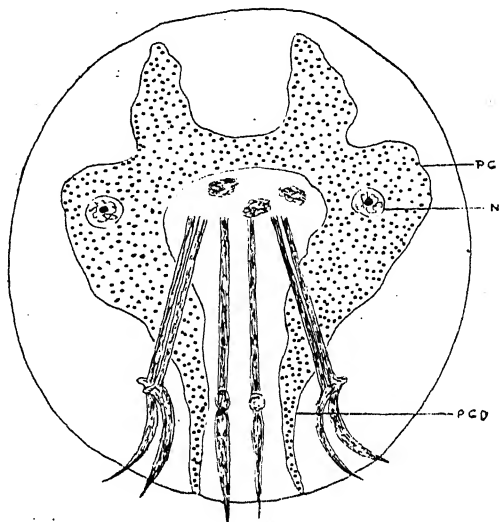


FIG. 1. Oncosphere of *Ochoristica indica* showing the penetration gland. N, Nucleus; PG, Penetration gland; PGD, Penetration gland duct.

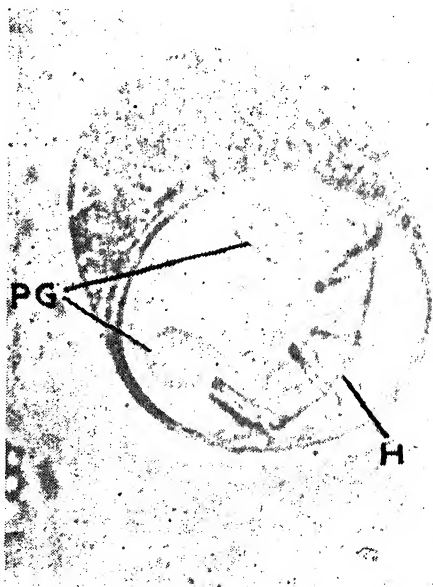


FIG. 2. Microphotograph of the egg of *Ochoristica indica* showing the hexacanth with the penetration gland; H, Hexacanth; P.G., Penetration gland. (Living unstained).

In so far as histochemistry is concerned, the following observations are pertinent. The secre-



tion of the gland exhibits an intensely positive PAS reaction which is fast to saliva digestion. With Best's carmine and with some basic protein techniques such as bromophenol blue, malachite green and light green the secretion of the gland gives negative results. No clear-cut positive reaction has been obtained with alcian blue. However, an inconstant positive reaction may occur with alcian blue after oxidation. The gland takes a green colour with toluidine blue and is negative to Sudan Black. B. Rybicka in a review on embryogenesis in cestodes has discussed the role played by this PAS-positive secretion of the oncosphere and states "The proteolytic and cytolytic role of the gland secretion seems to be unquestionable, although the nature of the enzymes involved has not been determined. The secretion appears to take part in the hatching of the oncosphere as well as its penetration of the intermediate host".

The observations of Sawada on the behaviour of the gland secretion in the oncosphere of *Raillietina cesticillus* are of more than passing interest. He has stated that after the oncosphere "has escaped from the shell membrane, the glandular secretion is discharged from the secretory pores in little droplets which bunch about the outside of the pores; very active Brownian movement of the granules occurs in the most recently expelled droplets". There is in this observation a fine analogy between the oncosphere which has to cause erosion of gut-wall and some mammalian blastocysts which have to erode the uterine epithelium prior to implantation and it is tempting to make the following tentative observations. In the case of the blastocyst of the guinea-pig, it has been described by Amoroso<sup>6</sup> that in the abembryonal attachment cone of the trophoblast fine protoplasmic processes are developed in preparation for the formation of tiny vesicles. These vesicles enclosing granules in Brownian movement move away from the site of formation. It would be most interesting to make a histochemical analysis of the forming vesicles in the blastocyst. Presumably the vesicles are indeed like those in the oncosphere charged with the task of bringing about erosion of tissues. One could consider the oncosphere as implanting in the host tissues just as the blastocyst implants itself in the endometrium of the uterus.

Thanks are due to Prof. P. N. Ganapati for encouragement and interest. One of us

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Dept. of Zoology, P. RAMA DEVI.  
Andhra University, K. HANUMANTHA RAO.  
Waltair, January 25, 1968.

1. Millmann, R. E., *J. Parasit.*, 1955, **41**, 424.
2. Ogren, R. E., *ibid.*, 1957, **43**, 503.
3. Rybicka, K., *Advances in Parasitology*, Ed. Ben Dawes, 1966, **4**, 107.
4. Sawada, J., *Expt. Parasit.* 1961, **11**, 141.
5. Silverman, P. H., *Ann. Trop. Med. Parasit.*, 1955, **49**, 326.
6. Amoroso, E. C., *Mem. Soc. Endocrin. Ugy*, Ed. P. Eckstein, 1959, **6**, 50.

### RADIATION INDUCED PROGRESSIVE MUTANTS IN BAJRA (*Pennisetum* *typhoides* STAFF AND HUBB.)

INDUCTION of mutations to rectify one or two undesirable characters in an established cultivar has been very effective as an alternative to the backcross technique in evolving improved strains in a variety of crop plants. While bringing about an improvement in a variety with reference to a few specific characters other genetic attributes of the parent are realised in full intensity as they remain unaffected. This technique has been very successful in many self-pollinated crops.<sup>1-3</sup> Induced mutants may be of great value in the genetic improvement of cross-pollinated crops as well.

Mutation experiments were undertaken in Pusa Moti, an improved variety of bajra (*Pennisetum typhoides*) in an attempt to effect certain changes in plant height and ear characters. Pure and dry seeds of this variety were irradiated with Gamma rays (Source Co<sup>60</sup>-200 curies) at the Gamma Garden at I.A.R.I. in 1963. The LD 50 (50% lethal dose) was determined by pilot experiments. This dose was near 25 kr. Irradiated seeds with 25 kr. were sown in the field. M<sub>1</sub> plants were selfed and M<sub>2</sub> generation was raised.

Out of 215 lines of M<sub>2</sub> raised, eight segregated for chlorophyll mutations—five lines for *albina* and *striata*. *Albina* mutants proved lethal whereas *striata* ones developed into stunted plants. Three lines segregated for dwarfness having height range from 105 cm. to 130 cm. at maturity as against 200 cm. of the parent. One line segregated for bristled ear mutants. Dwarf and bristled ear mutants were followed in M<sub>3</sub> and M<sub>4</sub>. Uniform lines for 'bristled ear' have been obtained but those for dwarf plants are still segregating. The ear dimensions of these mutants are similar to

those of the control Pusa Moti. No dwarf plants or plants with bristled ears were observed in the control.

Plants with bristled ears and the dwarf plants are the progressive macro-mutants obtained in this experiment. Such desired changes in an established variety increases the potentiality and thus the utility of the improved strain evolved thereby.

Bristled, i.e., dense awned mutants of *Pennisetum typhoides* were also obtained by Bilquiz *et al.* by subjecting the seeds to X-radiation. Bristled ear character helps in increasing the grain yield of the plant mainly through cutting down the damage by birds, hence the significance of this character.

I am grateful to Dr. M. S. Swaminathan, Director, Indian Agricultural Research Institute, Delhi, for his advice and useful suggestions.

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# INHIBITION OF GROWTH OF THE SEEDLINGS OF *PHASEOLUS RADIATUS* LINN. BY *ORTHO*-FLUORO PHENOXY ALPHA-METHYL ACETIC ACID

A LARGE number of phenoxy acid derivatives<sup>1-6</sup> are known to influence the growth in plants, but practically no work has been done on *ortho*-fluoro phenoxy-alpha-methyl acetic acid. This chemical strongly inhibited the growth of the seedlings of *Phaseolus radiatus*. It is a crystalline solid, yellow brown in colour, sparingly soluble in water, but readily soluble in alcohol. This chemical was used for the first time in biological research by the author.

The seeds of *Phaseolus radiatus* were soaked in solutions of different concentrations of *ortho*-fluoro phenoxy-alpha-methyl acetic acid for six hours in an incubator maintained at 30° C. To prepare the solution, 0.5 gm. of chemical was dissolved in 10 ml. of absolute alcohol and then volume was made up to 1 litre with distilled water. From this stock solution, other solutions of different concentrations were prepared.

After the soaking treatment, the seeds were thoroughly washed with distilled water and were allowed to germinate in sterilised petridishes lined with moist filter-papers. The length of the entire seedling, radicle and hypocotyl was recorded after every 12 hours for 72 hours after 24 hours of germination. The mean length of the seedling radicle and hypocotyl was recorded from the 30 seedlings grown in 3 petridishes, each containing 10 seeds. The result has been given in Table I.

The chemical completely inhibited the growth at a concentration of 50 ppm and above. Even at 1 ppm there was marked difference in

1. Bilquiz, A. F., Magne, C. and Martin, J. B., 'The use of induced mutations in plant breeding,' *Report of the F.A.O. I.A.E.A. Technical Meeting, Rome, 1964*, Pergamon Press, Oxford & London, 1965, p. 585.
2. Borg, G., Froier, K. and Gustafsson, A., *Pallas Bailey—A Variety Produced by Ionizing Radiation. Its Significance for Plant Breeding and Evolution*, Second U.N. Intern Conf. Peaceful Uses of Atomic Energy, Geneva, 1958.
3. Jaganathesan, D., Swaminathan, M. S. and Puri, H. P., 'Breeding for resistance to jassids in cotton—Use of induced mutations,' *Indian Cotton Growing Review*, 1963, 5, 96.
4. Pal, B. P. and Swaminathan, M. S., 'Induced mutations. evolution and wheat breeding,' *Proc. Nat. Inst. Sci. India*, 1961, 26, 109.

TABLE I

Mean length in centimeters of the seedlings, radicle and hypocotyl after the soaking treatment of the seeds with *ortho*-fluoro phenoxy-alpha-methyl acetic acid solution

Concentration of the chemical in ppm	Time in hours											
	36			48			60			72		
	S	H	R	S	H	R	S	H	R	S	H	R
0	7.8	3.2	3.8	12.6	4.5	7.3	23.8	11.4	10.5	24.3	13.3	11.0
1	6.6	2.4	3.7	11.8	4.0	5.5	18.2	11.1	7.5	18.6	11.6	7.7
5	3.9	2.1	2.1	6.3	4.0	2.8	9.4	7.0	2.8	10.2	7.4	2.9
10	3.8	1.9	1.1	4.1	3.3	1.5	7.0	6.8	1.8	9.5	7.2	2.3
25	2.1	1.4	0.8	2.2	1.5	1.0	2.4	1.6	1.5	3.5	1.6	1.5
50	1.5	0.7	0.8	1.8	0.8	1.0	1.9	0.8	1.1	2.0	0.8	1.1

R = Radicle, H = Hypocotyl, S = Seedling.

growth of controlled and treated seedlings. The radicle showed a swelling, in seedlings treated with the 50 ppm solution of the chemical (Fig. 1). More than 80% inhibition

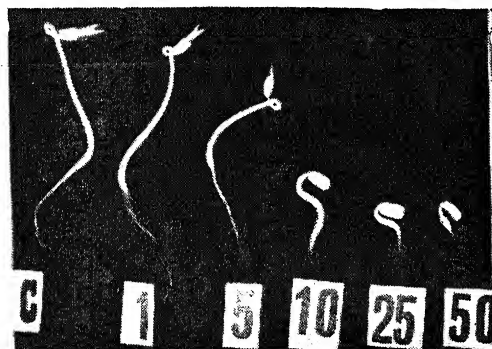


FIG. 1. Seedlings of *Phaseolus radiatus* Linn. after 48 hours of germination. Extreme left is control (C). The concentration of *ortho*-fluoro-phenoxy-alpha-methyl-acetic acid in ppm is written below the seedlings.

in the growth of the radicle was recorded after 48 hours of germination in the seedlings treated with 10 ppm solution of the chemical while inhibition of the hypocotyl growth was only 45%. At a concentration of 25 ppm radicle and hypocotyl growth was inhibited by 85 and 70% respectively, after 48 hours of germination.

The inhibition of growth did not appear to be due to toxic effect of this chemical on the seedlings but probably it worked as an anti-auxin. The inhibition of growth might be due to decreased carbohydrate metabolism<sup>7</sup> in the seedlings treated with the chemical.

I am thankful to Dr. Somari Giri, University of Gorakhpur, for kindly providing the chemical, and to Prof. U.N. Chatterji for necessary guidance in the work.

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The University,  
Jodhpur (India), September 14, 1967.

1. Aberg, B., *Intbr. Högsk. Ann.*, 1953, 20, 241.
2. —, *Physiol. Plant.*, 1954, 7, 241.
3. Burstrom, H., *Ibid.*, 1951, 4, 641.
4. Fredga, A. and Matell, M., *Ark. Kemi.*, 1952, 4, 325.
5. Hansen, B., *Bot. Notiser.*, 1954, 230, 318.
6. Matell, M., *Ark. Kemi.*, 1954, 7, 437.
7. Tewari, M. N., *Ph.D. Thesis*, Jodhpur University, India 1965.

# AN ESTIMATION OF PROTEIN, ASCORBIC ACID AND MINERAL MATTER CONTENT IN SOME INDIGENOUS AND EXOTIC VARIETIES OF GRAM (*CICER ARIETINUM* L.)

A COLLECTION of 40 varieties of gram was tested at Millet Research Station, Ferozepur, for a number of economically important characters. A study of their protein content, and the total mineral matter content was also made. Argikar (1956) had reported a higher vitamin C content in a green-cotyledon variety of gram. Since, some of the varieties in the present material were green-cotyledonous types, a study of vitamin C content was also made. The 40 varieties were sown in a randomised block design experiment at Ferozepur (Punjab) with five replications. A random sample of 50 gm. seeds from the bulk of all the replications of a variety was taken to form the base from which samples were further taken out to estimate the protein, vitamin C and total mineral matter content. Protein was estimated by adopting micro-kjeldahl method and vitamin C by the titrimetric method with indo-phenol dye, as given in the AOAC methods.

The varieties tested and their origin along with their respective contents of the constituents estimated, have been set out in Table I. The highest amount of protein in the varietal collection was estimated at 29.8%, viz., in the varieties Algeria 3444, Frontier 8, Gaddag S2 and Gram Cross A. The lower limit of the range in protein content (18.4%) was represented by the varieties Tehran 29 and Ahmedabad S1. The variation in respect of vitamin C content was between 6.00 and 2.15 mg. ascorbic acid per 100 gm. of seed material. The green-cotyledonous G.G. Bijapur and G.G. Ferozepur were on top for vitamin C content, with respective values of 6.00 and 5.25 mg. The variation among the varieties for mineral matter content was relatively small, i.e., a minimum of 4.12% in case of N.P. 17 and maximum, 4.67 in case of Sambalpur. It may be seen that none of the introduced varieties exhibited superiority over indigenous varieties for the chemical constituents studied. At the most they were found to be at par with the indigenous ones.

TABLE I

*Protein, vitamin C and total matter content in a collection of gram varieties*

Sl. No.	Name of variety	Origin	Protein	Total mineral matter %	Vitamin C (mgm./100 gm. of seed material)
1	U.S.A. 606	.. U.S.A.	23.6	4.38	3.10
2	U.S.A. 609-C	.. "	23.6	4.57	2.80
3	U.S.A. 613-A	.. "	24.5	4.36	2.75
4	Tehran	.. Iran	21.9	4.49	3.35
5	Tehran 28	.. "	27.1	4.18	3.12
6	Tehran 29	.. "	18.4	4.43	2.15
7	Tehran 32	.. "	24.5	4.33	2.65
8	Baghdad S4	.. Iraq	21.9	4.36	2.52
9	Algeria 418	.. Algeria	25.4	4.33	2.15
10	Algeria 3444	.. "	29.8	4.44	3.05
11	B. K. 318	.. Burma	20.1	4.20	2.35
12	B. N. 3118	.. "	19.3	4.17	3.12
13	B.N.W.R.	.. "	23.6	4.32	4.15
14	Mandaley	.. "	21.0	4.35	2.35
15	Campoline Senza	.. Bulgaria	23.6	4.56	2.76
16	Ceylon 2	.. Ceylon	22.8	4.35	3.35
17	Egypt S2	.. U.A.R.	23.6	4.44	2.15
18	Attock 234	.. Pakistan	26.3	4.40	2.75
19	Frontier 3-A	.. "	26.3	4.32	3.70
20	Frontier 8-A	.. "	29.8	4.24	2.36
21	Ahmedabad S1	.. India	18.4	4.51	2.55
22	Bara Chana	.. "	21.0	4.21	2.70
23	Broach	.. "	20.1	4.35	3.15
24	Gaddag S2	.. "	29.8	4.52	3.00
25	Green Gram Bijapur	.. "	23.6	4.43	6.00
26	Isthena S2	.. "	28.9	4.87	2.85
27	Poona Black	.. "	27.1	4.15	3.15
28	Gram Gross-A	.. "	29.8	4.23	4.05
29	Kanpur	.. "	22.8	4.32	2.55
30	Nadiad S1	.. "	22.8	4.20	3.00
31	Kadaley 3	.. "	23.6	4.41	3.20
32	N. P. 17	.. "	21.9	4.12	2.45
33	Sambalpur	.. "	21.0	4.67	2.70
34	C 169	.. "	22.8	4.53	3.35
35	Double R-1	.. "	26.3	4.36	2.86
36	Ferozepur 4	.. "	27.1	4.51	3.35
37	Green Gram Ferozepur	.. "	21.0	4.13	5.25
38	Selection 1	.. "	23.6	4.37	2.88
39	11/48-7. G24	.. "	26.3	4.47	2.80
40	Punjab 7	.. "	20.1	4.60	2.85

A highly significant negative correlation with  $r$  value of  $-0.369$  was observed between the mineral matter content and the ascorbic acid content. However protein content was not associated with either of the other two constituents.

Dept. of Plant Breeding,  
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S. K. ARORA.

1. Argikar, G. P., *Indian J. Genet.*, 1956, 16 150
2. *Official Methods of AOAC*, 9th ed., 1960.

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## REVIEWS AND NOTICES OF BOOKS

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### International Review of Cytology (Vol. 22).

Edited by Danielli and Bourne. (Academic Press, New York and London), 1967. Pp. xvi + 420. Price \$ 19.00.

Volume 22 of this well-known series contains the following articles: "Current Techniques in Biomedical Electron Microscopy," by Saul Wischnitzer; "The Cellular Morphology of Tissue Repair," by R. M. H. McMinn; "Structural Organization and Embryonic Differentiation," by Gajanan V. Sherbet and M. S. Lakshmi; "The Dynamism of Cell Division during Early Cleavage Stages of the Egg," by N. Fautrez-Firlefyn and J. Fautrez; "Lymphopoiesis in the Thymus and Other Tissues: Functional Implications," by N. B. Ceerett and Ruth W. Tyler (Caffrey); "Structure and Organization of the Myoneural Junction," by C. Coers; "The Ecdysial Glands of Arthropods," by William S. Herman; "Cytokinins in Plants," by B. I. Sahai Srivastava.

C. V. R.

### Annual Review of Nuclear Science (Vol. 17).

Edited by Emilio Segre. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California, 94306, U.S.A.), 1967. Pp. v + 546. Price U.S.A.: \$ 8.50; elsewhere: \$ 9.00.

Volume 17 of this well-known series contains the following articles: The Optical Model of the Nucleon-Nucleus Interaction; Application of Atomic Beams to Elementary Particle and Nuclear Physics; Semiconductor Nuclear Radiation Detectors; Thermalization of Neutrons in Condensed Matter; Motion of Energetic Particles in Crystals; Materials for High-Temperature Nuclear Reactors; Isotopic Abundance Anomalies in the Solar System; X-rays from Stars and Nebulae; Determination of Absolute Disintegration Rates by Coincidence Methods; Sources of Polarized Ions; Characteristics of Typical Accelerators; The Effects of Ionizing Radiation on Nucleic Acids of Bacteriophages and Bacterial Cells; Corrections to Weak Interactions; Correction to Muonium; Some Related Articles Appearing in other *Annual Reviews*.

C. V. R.

### Annual Review of Genetics (Vol. I).

Edited by H. L. Roman. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1967. Pp. 334. Price U.S.A.: \$ 8.50; elsewhere: \$ 9.00.

This volume contains the following articles: "Human Genetics," by H. Eldon Sutton; "Population Genetics," by R. C. Lewontin; "Non-Random Disjunction in *Drosophila*," by E. Novitski; "Bacterial Conjugation and Extrachromosomal Elements," by Stanley Falkow, E. M. Johnson and L. S. Baron; "Structural Relationships Between Gene and Protein," by Charles Yanofsky; "Developmental Genetics," by Heinrich Ursprung; "Molecular Aspects of Immunogenetics," by Donald C. Shreffler; "Biochemical Aspects of *Drosophila*," by Herschel K. Mitchell; "Fungal Genetics," by Sterling Emerson; "Radiation Genetics," by Sheldon Wolf; "Biochemical Genetics of Higher Plants," by Oliver E. Nelson, Jr.; "Plant Breeding," by G. F. Sprague; "Animal Breeding," by Alan Robertson.

C. V. R.

### Current Topics in Bioenergetics (Vol. 2).

Edited by Sanadi. (Academic Press, New York and London), 1967. Pp. xiii + 373. Price \$ 14.50.

This serial publication brings together reviews on the closely related multidisciplinary research in such fields as photosynthesis, bioluminescence, nerve conduction, oxidative phosphorylation, muscle contraction, stretch reception, phototaxis and protoplasmic streaming. The articles range from descriptions of gross biological phenomena to sophisticated studies at the molecular level depending upon the state of development in the respective problems. Biochemists, biophysicists, physiologists, chemists, botanists, zoologists and cell biologists will find this publication a valuable guide to current science literature. C. V. R.

**Stellar Evolution.** By A. J. Meadows. (Pergamon Press, Ltd., Headington Hill Hall, Oxford.) Pp. 169. Price: Hard Cover: 25 sh. or \$ 4.50; Flexi Cover (net): 12 sh. 6 d. or \$ 1.95.

This is a publication in Pergamon International Popular Science Series. It explains in

general terms the present state of our knowledge on a subject of universal interest but in whose understanding there are taking place new ideas. These have come as a result of major findings due to improved techniques of observation and study. The emphasis in the treatment is, of course, on those aspects which have a more certain basis and are fairly reliable, such as the characteristics of stars, their structure, birth and evolution along the main sequence, energy resources and nuclear reactions in the stars' cores. A full chapter is devoted to the Sun as a star, its evolution, its contraction to the main sequence, the nuclear reactions in its core, the solar magnetic field and the solar corona. The final chapters are devoted to Red giants, old age and death of stars, galaxies and such other topics concerning which our knowledge is still limited and in a fluid state. A. S. G.

**Upper Mantle Project** (*A Symposium Proceedings*). (Copies can be had from the Director, National Geophysical Research Institute, Hyderabad-7, India.) Pp. xxxviii + 540. Price Rs. 25 (India), \$ 5 (Foreign).

A symposium on Upper Mantle Project was organized at the National Geophysical Institute, Hyderabad, during January 4-8, 1967. About 200 Indian and foreign scientists participated in the symposium. The present publication contains the proceedings of the inaugural and concluding sessions, and a collection of selected papers presented at the symposium.

The forty-four papers are grouped under the following heads: Magmas and Their Relationship to Tectonics of Crust and Mantle (6); Seismology and Gravity Studies (7); Physics of the Crust and Mantle (6); Geological, Geophysical and Geochemical Studies in Various Regions of India (22); Studies on Continental Drift (3). A. S. G.

**The Teaching of Ecology**. Edited by J. M. Lambert. (Blackwell Scientific Publications, 5, Alfred Street, Oxford, England). Pp. 294. Price 47 sh. 6d.

Ecology or the study of the relationships between organisms and their environment, far from being regarded as a 'luxury' subject, has come to be recognized as an integral part of scientific education. Although, by tradition, ecology forms a subsection of biology its study involves an insight into such various discip-

lines as geology, pedology, climatology, physiography, archeology, besides physics and chemistry. In this context the teaching of ecology at all levels of education is considered a primary necessity. Taking this for granted, the questions that naturally arise are: (1) what should be taught at any given level, (2) where is such teaching to be carried out, and (3) how it is to be taught.

To arrive at a consensus on the various problems involved the British Ecological Society devoted its 1966 Symposium to "The Teaching of Ecology" which was attended by some 400 persons intimately concerned with ecology and its teaching. The present volume contains the text of 27 invited papers to the symposium. The contributions range from considerations of the basic problems, through the practical teaching of ecology in schools, colleges and universities, to discussions of career opportunities available at home and abroad to trained ecologists. Besides its general interest to educationists and organizers of science teaching, the book will be of special use to teachers as there are papers concerned with details of instructional courses and useful ecological exercises. A. S. G.

#### Books Received

**Stellar Evolution**. By A. J. Meadows. (Pergamon Press, Ltd., Oxford), 1967. Pp. vi + 169. Price 25 sh.

**You Are Extraordinary**. By R. J. Williams. (Random House, 457, Madison Avenue, New York-22, N.Y.), 1967. Pp. xii + 252. Price \$ 5.95.

**Challenging Mathematical Problems with Elementary Solutions**. By A. M. Yaglom and I. M. Yaglom. (Holden-Day, Inc., 500, Sansome St., San Francisco), 1967. Pp. ix + 214. Price \$ 7.25.

**Non-Linear Partial Differential Equations—A Symposium on Methods of Solution**. By W. F. Ames. (Academic Press, New York), 1967. Pp. xv + 316. Price \$ 14.00.

**Lipid Chromatographic Analysis** (Vol. I). By G. V. Marinetti. (Marcel Dekker, Inc., 95, Madison, New York 10016), 1967. Pp. xv + 537. Price \$ 23.50.

**A Course in Modern Techniques of Organic Principles of the Colloidal State**. By G. D. Parfitt. (The Royal Institute of Chemistry, 30, Russell Square, London W.C. 1), 1967. Pp. 35. Price 6 sh. 0d.

# AMALGAM CATHODE IN VOLTAMMETRY

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**P**OLAROGRAPHY using amalgam anodes has been studied, particularly in relation to stripping analysis. The use of amalgam cathode is rather limited, because of the difficulty of obtaining meaningful results on the conventional d.c. polarographs. This study is now possible using the fast voltage scanning instruments such as cathode ray polarographs.

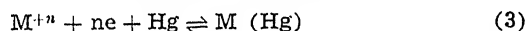
The study of amalgam cathode will throw some light on the mechanism of electrode reaction. The fundamental electrode reduction process on DME can be written as



and if the metal dissolves in mercury, it can further be written as



These two equations can be combined together to form a composite equation



If then instead of mercury, an amalgam is taken as cathode, then the forward reaction may be slowed down. This will be particularly true of the reduction of the cation, which forms the amalgam in cathode, namely the reduction of cadmium ions on the cadmium amalgam cathode. It will also be interesting to study the other amalgam forming cation reduction on cadmium amalgam as well as the reduction of non-amalgam forming ions such as chromate, etc.

A 50 ml. pyrex beaker fitted with a rubber bung with perforations for inserting electrodes and bubbling and exit of nitrogen serves as

the polarographic cell.<sup>1</sup> The electrodes system used as J type mercury pool cathode (0.1215 cm.<sup>2</sup>, area) and molybdenum wire reference electrode (1.5 cm. long, 22 s.w.g.). The reduction was followed on the Differential Cathode Ray Polarograph, model A 1660, manufactured by the Southern Analytical Ltd., England. The temperature was kept constant at  $30 \pm 0.1^\circ \text{C}$ . by an electronically operated thermostat. The supporting electrolyte used is 0.1M potassium chloride prepared from AnalaR grade reagent. All the other solutions were prepared from their AnalaR grade reagents and standardised in the usual way. Various concentrations of cadmium amalgam were prepared by weighing AnalaR grade cadmium metal and adding it to the weighed quantity of double distilled mercury. It was then placed on the water-bath covering it with 0.1N sulphuric acid and the solution was allowed to take place for forty-five minutes to one hour.<sup>10</sup> The cadmium amalgam thus formed was kept under 0.1N sulphuric acid solution. Before filling the amalgam in the J electrode, it was first washed with distilled water and then dried on the filter-paper. Compared to the dropping amalgam electrode, the quantity of amalgam required for the J type electrode is considerably smaller. Molybdenum reference electrode, which is being extensively used in our laboratory,<sup>2,9</sup> is found to be very useful in this work.

The results obtained for different cation reductions using different cadmium amalgam concentrations for cathode are given in Table I.

TABLE I  
Wave characteristics obtained for cadmium amalgam cathode

Cathode : J type pool (area—0.1215 cm.<sup>2</sup>). Anode : Mo wire (1.5 cm., 22 s.w.g.)  
Ion concentration :  $1 \times 10^{-4} \text{M}$ . Supporting electrolyte 0.1M KCl.

$i_p$ $\mu$ amp for % amalgam				Ion	$E_p$ , V for % amalgam			
0.0	0.1	0.5	2		0.0	0.1	0.5	2.0
19.0	16.0	13.2	12.6	Cd <sup>++</sup>	-0.58	-0.86	-0.85	-0.89
66.8	20.4	20.0	8.0	Cu <sup>++</sup>	-0.20	-0.26	-0.60	-0.60
38.2	27.0	14.5	5.1	Ni <sup>++</sup>	-1.1	-1.20	-1.22	-1.18
68.8	38.2	3.0	0.70	Zn <sup>++</sup>	-1.06	-1.07	-1.17	-1.16
Current is unstable 109.7	erratic	-64.0 } 24.0 }	30.0 } erratic }	Fe <sup>+++</sup>	-1.57	-1.67	-1.75	-1.88
				Sb <sup>+++</sup>	-0.47	-0.47	-0.61	-0.45
28.0	36.4	9.0	..	CrO <sub>4</sub> <sup>- -</sup>	-0.34	-0.26	-0.87	..
53.4	76.4	10.0	..		-1.20	-1.40	-1.17	..
400.9		45.0	76.0		-1.80	..	-2.00	-2.0

It is clear that for all the ions, the peak potentials shift towards negative side with the increasing cadmium amalgam concentration, the shift being very small for zinc and nickel. For cadmium reduction, even for 0.1% amalgam, the peak potential shifts by  $-0.30$  V., but then remains nearly constant upto 2% amalgam. A shift of  $-0.40$  V. occurs for copper only at 0.5% amalgam but remains constant thereafter. For iron, a maximum shift of 32 mV is obtained upto 2% amalgam. No change occurs for antimony upto 0.1%, but the reduction process splits into two steps thereafter. For chromate where three peaks are obtained for mercury electrode, the pattern is irregular, two peaks being obtained for 0.1%, three for 0.5% and one only for 2% amalgam concentration.

Kozlovskii and Bukhman reported that when metals in solution were more electropositive than metals in amalgam, a considerable change of half wave potential towards negative was observed.<sup>11</sup> In the present study, cadmium which is used as amalgam in cathode, occurs above copper and nickel in the electrochemical series, but is below zinc and iron.<sup>12</sup> Yet irrespective of their positions, the shift in each case is invariably towards the negative side.

The peak currents generally decrease with increasing amalgam concentration. The minimum decrease of  $6.4 \mu$  amp occurs in the case of cadmium reduction, and the maximum decrease of  $68 \mu$  amp occurs in the case of zinc. Whereas the peak potentials are not much affected for 0.1% amalgam, the peak currents are considerably reduced for the same amalgam concentration.

The following conclusions can be drawn from these observations.

The process of reduction and amalgamation occurs simultaneously. Equation 3, therefore cannot be split up into equations 1 and 2. If it were not the case, then the current values would not have changed with progressively concentrated Cd amalgam cathode. On the contrary, with the exception of cadmium, the current values change considerably even for 0.1% amalgam. It has therefore to be presumed that the forward reaction of equation 3 is retarded when amalgam cathodes are used.

The amalgam cathode does work as a red-ox indicator electrode in the same way as a simple DME functions in the reduction of non-amalgam forming ions. But the peak potentials and consequently the decomposition potentials are dependent upon the concentration of the

amalgam in cathodes. Generally with increasing amalgam concentration, the potentials are shifted towards more negative side, irrespective of their position in the electrochemical series, indicating that the overpotential increases with increasing amalgam concentration. The increasing overpotential essentially results in increasing irreversibility of the electrode reaction with the increasing amalgam concentration, thereby decreasing the polarographic current.

These elements such as copper, zinc which themselves form amalgam with mercury, also give peaks on cadmium amalgam cathode, with the formation of mixed amalgams.

The most noteworthy fact is that cadmium reduction peaks are obtained even for 2% amalgam cathode, with the least diminution in the current amongst all the other ions tried. A metal amalgam electrode is as good as or even better than the metal electrode itself as an indicator electrode for those metal ions in solution.<sup>13</sup> These results therefore can be explained on these considerations, though the decomposition potentials will be different on mercury and amalgam electrodes.

In the case of other ions, however, the amalgam electrode behaves like the alloy electrode, on the basis of pure mercury being considered as an unalloyed electrode. The efficiency and performance of the platinum electrode which acts as a red-ox and acid-base indicator,<sup>14</sup> markedly deteriorates when alloyed with small amounts of rhodium,<sup>15</sup> due to the increased irreversibility of the electrode processes. In a similar manner, cadmium amalgam efficiency diminishes for the reduction of ions other than cadmium.

We thank Dr. V. T. Athavale for his keen interest in this work.

1. Athavale, V. T., Burangey, S. V. and Dhaneshwar, R. G., *J. Electroanal. Chem.*, 1965, **9**, 169.
2. —, — and —, *Proc. of SAC Conference, Nottingham*, W. Heffer & Sons, Publishers, 1965, p. 446.
3. Dhaneshwar, R. G. and Kulkarni, A. V., *Indian J. Chem.*, 1966, **4**, 533.
4. Athavale, V. T., Dhaneshwar, M. R. and Dhaneshwar, R. G., *J. Electroanal. Chem.*, 1967, **14**, 31.
5. —, — and —, *Analyst*, 1967, **92**, 567.
6. Dhaneshwar, R. G., *Proc. on the Symp. on Electrode Processes*, Jodhpur University, 1968.
7. Dhaneshwar, M. R., "Voltammetric studies using different electrode systems," *Thesis*, Univ. of Poona, 1967.
8. Athavale, V. T., Apte, V. P., Dhaneshwar, M. R. and Dhaneshwar, R. G., Sent to the *Indian J. Chem.*



9. Apte, V. P. and Dhaneshwar, R. G., Sent to the *Talanta*.
10. Vartak, D. G. and Shetiya, R. S., *Indian. J. Chem.*, 1965, **3**, 533.
11. Kozlovskii, M. T. and Bukhman, S. P., *Chem. Abstr.* 1956, **50**, 16465 d.
12. Vogel, A. I., *A Text-Book of Quantitative Inorganic Analysis*, Published by Longmans, Green & Co. Ltd., 3rd Edn., 1951, p. 87.
13. Bishop, E. and Dhaneshwar, R. G., *Analyst*, 1963, **88**, 424 et. seq.
14. Apte, V. P. and Dhaneshwar, R. G., *Talanta*, 1966, **13**, 1595.
15. Athavale, V. T., Dhaneshwar, R. G. and Sarang, D. A., *Ibid.*, 1967, **14**, 1333.

## ATOMIC ABSORPTION SPECTROPHOTOMETRY AS A TECHNIQUE IN THE DETERMINATION OF VAPOUR PRESSURE OF METALLIC ELEMENTS

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**V**APOUR pressures of a number of metallic elements at various temperatures, measured by different techniques, have been reported by many workers.<sup>1</sup> The vapour pressures of elements like Ag, Au and Mn are extremely low even at flame temperatures, e.g., Ag has a vapour pressure of  $9.8 \times 10^{-10}$  mm. of Hg at  $800^\circ \text{K}$ , Au  $3.3 \times 10^{-10}$  mm. of Hg at  $1000^\circ \text{K}$ , and Mn  $3.6 \times 10^{-9}$  mm. at  $800^\circ \text{K}$ .

In this note, we indicate the applicability of the new technique of atomic absorption spectrophotometry (AAS) in the determinations of vapour pressures of elements like Hg, Ag, Au and Mn at different temperatures.

In the low vapour pressure range under consideration, the partial pressures obey the gas law, i.e.,

$$p = n k T \quad (1)$$

Absorbance  $A_T$ , by the metallic vapour (at temp. T), of the monochromated beam from an HC lamp is proportional to the concentration of atoms 'n' in the vapour phase. Therefore, we write from eqn.(1):

$$p = K_p \cdot A_T T \quad (2)$$

where  $K_p$  is a constant.

The absorbance values at a number of temperatures were obtained for Hg using a quartz window absorption cell having suitable heating and temperature measuring arrangements placed in the path of the monochromated beam (2537 Å) from a Hg vapour lamp. Vapour pressure (p) for Hg at these temperatures was read from standard Tables.<sup>1</sup> Figure 1 gives the results at various temperatures where the linearity of p vs.  $A_T T$  envisaged in eqn. (2) has been obtained.

Using the Clausius-Clapeyron's equation on variation of vapour pressure with temperature one derives the first approximate relation,

$$\log p = \alpha + \beta/T \quad (3)$$

where  $\alpha$  and  $\beta$  are constants characterising the element in a given phase, i.e.,  $\log p$  and  $1/T$  bear a linear relationship. Such relationships for the elements Hg, Ag, Au and Mn have been established by earlier workers at elevated temperatures ( $900-1000^\circ \text{K}$ ). Combining equations (2) and (3) one obtains:

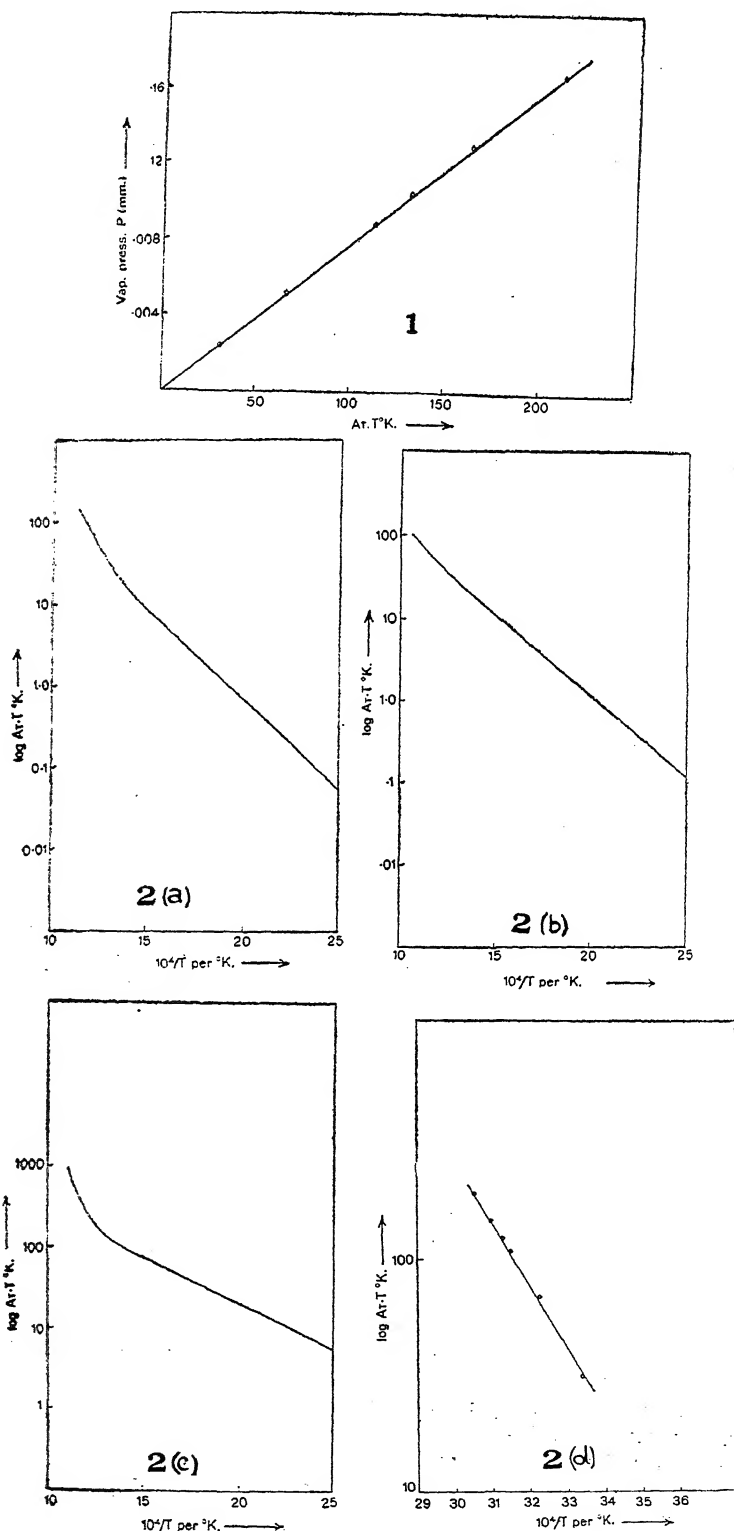
$$\log K_p \cdot A_T T = \alpha + \beta/T$$

or

$$\log A_T T = \alpha - \log K_p + \beta/T \quad (4)$$

i.e.,  $\log A_T T$  should bear a linear relationship with  $1/T$  in AAS measurements in the temperature range where the stipulation in relation (3) is valid.

A series of experiments were carried out in the temperature range of  $350-1000^\circ \text{K}$ . Metals Ag, Au and Mn used in the experiment were the specpure metals (Johnson and Mathey). These were placed respectively in the absorption cell as above. The cell chambers were flushed with argon then filled with the same to nearly atmospheric pressure and electrically heated to desired temperatures. Prior to taking readings on temperature and absorbance from the respective HC lamps, the argon gas flow was stopped for sometime in order to allow for the attainment of saturation vapour pressure. The linearity as envisaged in relation (4) is obtained in the lower ranges of the temperature for the metals Ag (3281 Å), Au (2428 Å) and Mn (2798 Å). The slopes are found to change in



FIGS. 1-2. Fig. 1. Vapour pressure *vs.*  $A_T T$  Curve for Hg. Fig. 2a.  $\log A_T T$  *vs.*  $1/T$  Curve for Ag. Fig. 2b.  $\log A_T T$  *vs.*  $1/T$  Curve for Au. Fig. 2c.  $\log A_T T$  *vs.*  $1/T$  Curve for Mn. Fig. 2d.  $\log A_T T$  *vs.*  $1/T$  Curve for Hg.

the neighbourhood of 700° K. and then tend to flatten to another linear domain (Fig. 2a-c).

The linearity at the lower temperature is obtained from pure sublimation process and the bending at higher temperatures is due to evaporation from a surface transformed from a solid surface to a quasi-liquid one. The same set of constants  $\alpha$  and  $\beta$  in Clausius-Clapeyron's equation does not hold under conditions of phase changes. No such change in slope was obtained with Hg—a liquid metal (cf. Fig. 2,d) where no phase change is

suspected in the temperature range (300–400° K.) of investigation.

It should be possible to calculate the absolute vapour pressures at different temperatures from considerations of relations (2) to (4) when the absolute vapour pressure is known at any one temperature. Further work is in progress and details will be published elsewhere.

1. Nesmeyanov, An. N., *Vapour Pressures of the Elements*, Translated and Edited by Carasso, J. I., Infosearch Ltd., London (Ed. 1963).

## TWO INTERESTING COPROPHILOUS FUNGI FROM INDIA \*

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IN the course of studies on the taxonomy and ecology of coprophilous fungi two interesting forms were collected both of which appear to be new to science and are described below.

### 1. *Tripterosporella coprophila* GEN. ET SP. NOV. (FIG. 1)

The fungus produces cleistothecia that are scattered, superficial, globose, black and opaque, 315–600  $\mu$  in diameter, and covered with hairs. The hairs are brown, septate, up to 600  $\mu$  long and about 3  $\mu$  wide, paler towards the apex and rounded at the tips. The peridium of the cleistothecium is membranaceous and pseudoparenchymatous. The asci are clavate-fusiform, unitunicate, 8-spored, hyaline, evanescent and 180–280  $\times$  15–23  $\mu$ , the spore mass being 126–153  $\times$  15–19  $\mu$ . The paraphyses are thin and evanescent. The ascospores are biseriate, sometimes uniseriate or even triseriate especially during early stages of development, obliquely placed; they are at first continuous, long-cylindrical, hyaline, with a single row of refractive globules; the globules disappear later with the further development of the spores and their place is occupied by large vacuoles. When the spores

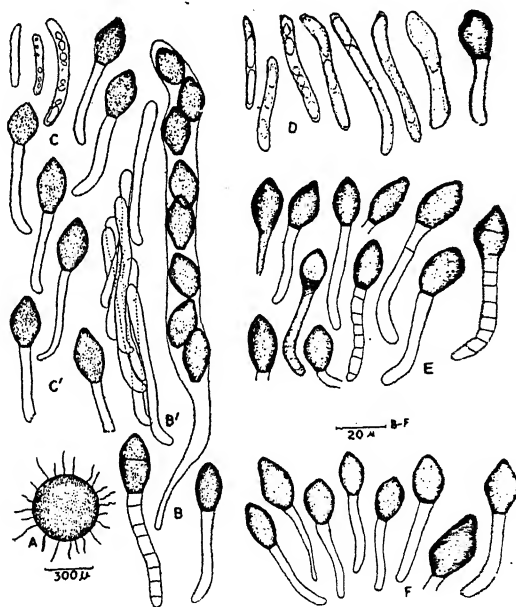


FIG. 1. *Tripterosporella coprophila* from type collection (Herb. RUBL No. 212). A, mature cleistothecium; B, ascus; B', ascospore-mass showing elongate filaments; C, showing stages of development of ascospores (juvenile stages); C', mature ascospores; D, stages in the development of ascospores; E, mature ascospores; note that tail-like cells of two ascospores are also pigmented; F, mature ascospores ex collection RUBL No. 196.

\* Memoir No. 56 from the Centre of Advanced Studies in Botany, University of Madras-1,

mature the vacuoles also disappear and a swelling develops at the upper end which gets cut off by a septum into a head cell and basal cylindrical tail-like cell. The head cell becomes dark brown or olivaceous brown, opaque, ovate to elliptical with slightly protruding apex and an apical circular germ pore, usually continuous, but rarely once or twice septate (septa seen only in young light brown spores), and  $21.6-25.6 \times 12.8-14.8 \mu$ . The tail-like cells remain hyaline and are cylindrical, curved near the base, continuous but sometimes septate, and  $35.2-43.2 \times 4.8-5.6 \mu$ . The septate tail-like cells are sometimes constricted at the septa. The ascospores are without gelatinous appendages or sheaths seen in *Bombardia* and *Sordaria* respectively.

The fungus at first sight appeared to resemble *Tripterospora*.<sup>1</sup> However, the mode of development of the ascospores (Fig. 1, C, D) somewhat differs from that described for *T. longicaudata* Cain<sup>1</sup> (compare Figs. 24-28 in Cain, 1956), the type species of the genus, in that the young spores are long and cylindrical in the fungus described here; on the other hand, in *T. longicaudata* even quite early in development the ascospores assume a clavate shape. A similar difference is also seen between the genera *Bombardia* Fries and *Podospira* Cesati, and in fact is one character on which these two genera are distinguished from each other. A further feature in which the ascospores of the present fungus differ from those of *Tripterospora longicaudata* is the fact that the ascospore or its basal tail-like cell may become septate and usually the free end of the tail-like cell is characteristically curved, a feature which again distinguishes *Bombardia* from *Podospira*. Since the characteristics listed here as separating the present fungus from the type species of *Tripterospora* are the same as those which separate two well-known Ascomycete genera, *Bombardia* and *Podospira*, it appears logical to place the present fungus in a genus distinct from *Tripterospora*.

#### *Tripterosporella* GEN. NOV.

Cleistothecia simplicia, fusca, cum pili vestiti absque ostiole vel stromate. Asci octospori, clavato-fusiformes, unitunicati. Ascosporee bicellulares, cellula apicali fusca, cellula basali caudae simili, absque ulla vagina gelatinosa vel appendice; cellula terminalis ornata germinationis poro; cellula

caudalis curvata ad basin, hyalina, ut plurimum continua, interdum septata. Ascosporee vermiformicylindricae in juvenili conditione. Species typica, *T. coprophila*.

Cleistothecia simple dark-coloured, with hair-like appendages, without ostiole or stroma. Asci 8-spored, clavate-fusiform, unitunicate. Ascospores 2-celled, with a dark head cell and basal tail-like cell (cauda), without any gelatinous sheath or appendages; head cell with a circular germ pore; tail-like cell curved at the base, hyaline, mostly continuous, sometimes septate. Ascospores vermiform-cylindrical during early development.

TYPE SPECIES: *Tripterosporella coprophila* SP. NOV.

Cleistothecia dispersa, superficialia, globosa, nigra, non-translucida, 315-600  $\mu$  diam., cum pilis vestiti. Peridium cleistothecii membranaceum et pseudoparenchymaticum. Asci fusiformes vel clavati, hyalini, unitunicati, octospori, evanescentes,  $180-280 \times 15-23 \mu$ ; sporarum massa  $126-53 \times 15-19 \mu$ . Ascosporee biseriatæ, interdum uniseriatæ vel etiam triseriatæ, præsertim in juvenili conditione, oblique dispositæ, primo continuæ, longocylindricæ, hyalinæ, ad maturitatem divisæ per septum in cellulam terminalem et cellulam cylindricam caudæ similem basalem; cellula terminalis fusco-brunnea, non-translucida, ovata vel elliptica, apice paulum protruso, germinationis poro apicali circulari ornata, vulgo unicellularis, rarius 1-2-septata (septis notatis tantum in sporis juvenilibus pallide brunneis),  $21.6-25.6 \times 12.8-14.8 \mu$ ; cellula caudalis hyalina, cylindrica, curvata prope basin, continua, rarius septata,  $35.2-43.2 \times 4.8-5.6 \mu$ . Ascosporee absque appendicibus vel vaginis gelatinosis ut in *Bombardia* et *Sordaria* respective.

Typus lectus e stercore pecorum at Chakrata a B.C.L. die 3 octobris anni 1962 (Herb. RUBL No. 212); collectiones allie: e stercore elephantum ad Jodhpur, a B.C.L., Sept. 1962 (Herb. RUBL No. 221); e stercore pecudum at Jodhpur, a B.C.L., 7 julii 1961 (Herb. RUBL No. 196).

#### 2. *Basifimbria aurea* GEN et SP. NOV. (FIG. 2)

The colonies on agar are circular, closely adpressed to the substratum and light golden in colour. The hyphae are creeping, hyaline, smooth, thin-walled, sparsely septate, branched and 4-5  $\mu$  wide. The conidiophores arise laterally or terminally from hyphae. They are

usually straight, sometimes slightly geniculate in the upper region, pale yellow, smooth, non-septate or 1-2-septate, simple or branched (once or twice), 146-78  $\mu$  long and 4.0-6.5  $\mu$  wide. The branches are about the same width as the main conidiophore. Each conidiophore produces at the tip a cylindrical denticle 1-2  $\mu$  long. The tip of the denticle enlarges into a globose swelling which finally develops into a

break of the denticle at any point below the septum, leaving part of the septate denticle on each conidium.

The fungus was isolated from horse dung from Mussoorie.

The 1-celled conidia borne on distinct dendrites and detachment of conidia by a break in the denticle resulting in part of the denticle remaining as a minute frill at the base of the conidium are characteristic. As far as we are aware, no genus of the hyphomycetes combines the features of this fungus and it is therefore considered appropriate to place it in a new genus *Basifimbria*; the generic name is suggestive of the basal frill of the conidium.

*Basifimbria* GEN. NOV.

Pertinet ad Hyphomycetes, producitque blastosporas. Conidiophora simplicia vel furcata supportant conidia denticulis insidentia in sympodulis. Conidia unicellularia, absque germinationis fissura vel poro, singula denticulo insidentia; denticulis evadentibus septatis; conidia liberantur per fracturam denticuli sub septo, sicque decorantur parte denticuli fimbriarum more ad basin.

Species typica: *B. aurea* SP. NOV.

Hyphomycete producing blastospores. Conidiophores simple or branched, bearing conidia on dendrites on sympodulæ. Conidia 1-celled, without germ slit or pore, each borne on a denticle; denticle becoming septate; conidia detached by a break in the denticle below the septum and thus carrying part of the denticle as a minute frill at the base.

Type species: *Basifimbria aurea* SP. NOV.

Coloniæ pallide aureæ. Hyphæ repentes, hyalinæ, leves, parietibus tenuibus, sparse septatæ, ramosæ, 4-5  $\mu$  latae. Conidiophora crecta vel decumbentia, recta; interdum paulum geniculata, pallide lutea, levia, continua vel semel bisve septata, simplicia vel semel bisve furcata, 146-178  $\mu$  longa, 4.0-6.5  $\mu$  lata, supportant conidia denticulis insidentia in sympodulis. Denticuli angusti, uniformiter lati, 1-2  $\mu$  longi, tandem evadentis septati. Conidia unicellularia globosa, rarissime ovoidea, pallide aurea colore, crassis parietibus prædita, penitus ornata projectionibus minutis paxillo similibus, absque germinationis fissura vel poro, 6.8-8.8  $\mu$  diam., acrogene producta et successive in sympodulis, liberata per fracturam denticuli sub septo et parte denticuli ad basin minute fimbriata.

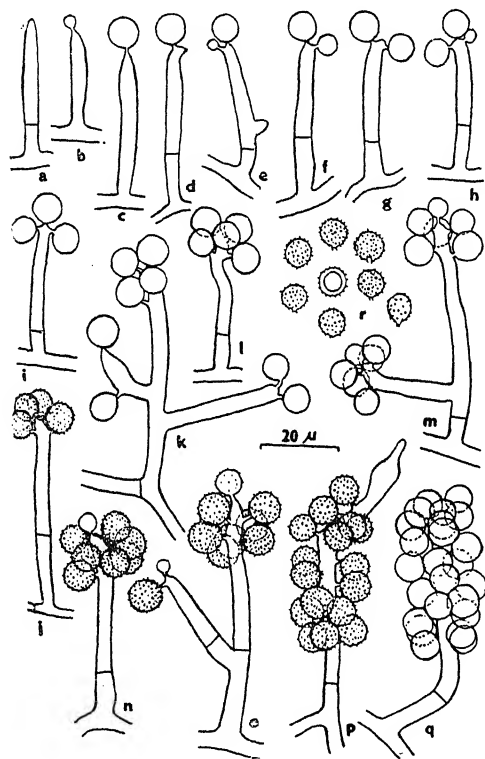


FIG. 2. *Basifimbria aurea* from type collection (Herb. RUBL No. 194). a-q, stages in the development of conidiophores and conidia; r, conidia.

conidium. After the formation of the conidium a septum is laid down in the denticle, separating the conidium from the conidiophore. The development of each conidiophore is sympodial and the conidia are produced acrogenously. Each conidiophore bears numerous conidia and thus looks like an 'ear'. The conidia-bearing region of the conidiophore is 64-88  $\mu$  long. The conidia are 1-celled, globose or rarely ovoid, light golden in colour, thick-walled, with verrucations or minute tubercles of almost uniform width, without germ slit or pore, and 6.8-8.8  $\mu$  in diameter. The conidia are shed by a

Typus lectus e stercore equino, in collibus  
Mauritii in U.P. in India, 12 October 1962, a  
B.C.L. Herb. RUBL No. 194).

We are grateful to the Rev. Fr. H. Santapau  
for the Latin translations of the diagnoses of

the new taxa. One of us (BCL) thanks the  
University of Rajasthan for award of a Uni-  
versity scholarship and a Fellowship.

1. Cain, R. F. "Studies of Coprophilous Ascomycetes,  
IV," *Can. J. Bot.*, 1956, **34**, 699.

## THE BREEDING OF HIGH PROTEIN RICES

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RICE as a food crop has some important  
advantageous features, namely, wide adapta-  
bility to different soils, high productivity per  
unit area and also the ability to yield well in  
plots with standing water. It is generally  
realised that the protein content of the milled  
raw rice, being between 5 and 7%, is low especi-  
ally when compared to wheat. Nutritionists  
advocate enriching the rice, alternatively sup-  
plementing with high protein food. It is a  
challenge to rice breeders to evolve high pro-  
tein varieties.

A large number of grain (rice) protein esti-  
mations have been made in this Institute using  
a number of rice genotypes grown in the two  
rice seasons and under varying manurial treat-  
ments. It was consistently found that the rice  
protein percentage is the end result of geno-  
type/environment interaction. Precise control  
of supply of the major nutrients is achieved  
in water cultures and one water culture experi-  
ment showed that N absorption upto maturity  
increased protein content of grain. In another  
experiment using the popular short duration  
variety Ptb. 10, and water culture, it was  
found that with N concentration of 200 parts  
per million the rice protein could be raised  
to 18%, when the nutrient solution is retained  
to maturity. Protein estimation in these and  
other experiments were from brown rice with  
intact pericarp and embryo, the factor 6.25  
being used to convert N values to protein. A  
further series of pot experiments showed that  
the genotype controlled the upper limits of  
protein, as for instance the cultivated rice of  
West Africa, *O. glaberrima* surpassed some  
popular *indica* varieties in protein content at  
high rates of N application.

In an early study in this Institute, Sampath  
and Seshu<sup>1</sup> had compared protein content of a  
few genotypes and had suggested that the  
morphological character "long glume" may be  
correlated with high protein content. Subse-  
quent work failed to confirm this suggestion,  
but in the screening, the variety *Pirurutong* of  
Philippines<sup>2</sup> having long glumes was found to  
have protein content of 10.4% and this is  
significant when under similar conditions the  
U.S.A. variety *Rexoro* had a protein content  
of 7.40%. For, in the *Annual Report of the  
International Rice Research Institute*<sup>2</sup>, (1961-62)  
a table gives the proximate percentage com-  
position of 16 rice varieties from different  
countries, and in this group *Rexoro* had the  
highest protein content.

A project for breeding high protein rices  
was started in this Institute in 1965, using  
*Pirurutong* as one parent and the *japonica*  
variety *Gaisen mochi* as the other parent. The  
*japonica* was used as the other parent to con-  
tribute to productivity of the progeny selec-  
tion through genes for short height, and  
manurial response. Chemical analysis of a few  
F<sub>3</sub> selection showed that the protein percent-  
age varied with the plant, and a few having  
more than 10% protein were multiplied. In  
1967 Kharif season (July to October) the  
cultures were fertilised with ammonium sul-  
phate in two applications, the total being  
equivalent to 90 lb. N/acre. Analysis of  
samples showed that there was considerable  
variation between plants but in four plants  
the protein content of rice exceeded 15%.  
These are being multiplied in highly manured  
plots.

The cultures are potentially high-yielding but are susceptible to bacterial leaf-blight. They have been subjected to chemical mutagenesis and the  $M_2$  generation is being grown, to be screened for blight resistance. However, there are other promising rice varieties which could be used in a new breeding project and it is necessary to consider the criteria to be used in selecting the parents. It is necessary to know about the range of variability amongst common varieties and the compilation by Julian<sup>3</sup> on the physico-chemical data on the rice grain is very useful. Since high protein content should be accompanied by high-yielding capacity, it is necessary to select parents having other desirable features, for example, resistance to *Piricularia*, inasmuch as heavy manuring is to be adopted. In this connection, the report by Swaminathan<sup>4</sup> that mutation breeding has given a high-yielding high protein wheat strain, and parallel results are to be expected in rice, is important. Such mutants, even if not high-yielding, are of value in breeding. For efficient breeding, it is, however, desirable to investigate the genetic control of protein level in the grain.

The hybridisation programme now reported needs to be continued for the following reason. Both the parents used have the "Waxy" endosperm, that is the starch is predominantly amylopectin. This character is recessive to the normal starchy (amylose + amylopectin) and the genetic locus is designated *wx*. From this hybrid, segregation to "starchy grain" cannot be expected, though theoretically by a rare recombination a new gene may be constituted and starch types changed. It is considered probable that the capacity to accumulate protein is linked to the starch structure,

because in the rice grain the protein is not restricted to the pericarp and embryo, though the concentration is more in these structures. The losses in protein on milling and polishing the grain are mainly due to loss of embryo and partly to loss of bran. It can be easily seen that the "waxy" type of grain is never translucent, but is whitish and this opacity is due to air spaces accompanying drying and shrinking between grain filling and harvest. The waxy endosperm is considered to be "permissive" of protein accumulation, and inferentially the genetic loci concerned with synthesis of the protein are different. There is a hope that in breeding from "waxy" parents, a segregant parallel to "Opaque 2" the high lysine maize can be isolated.

There is one other approach to breed high protein rices and this is to evolve fertile productive autotetraploids. Experiments in this Institute have shown that in tetraploids the protein is more than in the corresponding diploids and that by hybridising different homozygous tetraploids the inherent semisterility can be reduced. However the tetraploid cultures now being grown in this Institute give grains having 10-12% protein only even when heavily manured. The production of new tetraploids having higher protein content and also good productivity is likely to be arduous.

1. Sampath, S. and Seshu, D. V., *Curr. Sci.*, 1957, 26, 139.
2. *Annual Report, International Rice Research Institute*, 1961-62, p. 45.
3. Julian, Bienvenido, O., *International Rice Research Institute Technical Bulletin*, 1966, 6.
4. Swaminathan, M. S., *Farmer and Parliament*, 1968, 3, 10.

## LETTERS TO THE EDITOR

ON THE MEASUREMENT OF TOTAL  
ATTENUATION COEFFICIENTS OF  
X-RAYS BELOW THE K-ABSORPTION  
EDGE IN DIFFERENT ELEMENTS

AN experimental method to determine the total attenuation coefficients of X-rays, just below the K-absorption edge in various elements has been developed and used to measure the absorption coefficients of the K-shell characteristic X-rays of lead, gold, tungsten, tin and silver in respective elements. The method consists of irradiating the targets of various thicknesses of element under investigation by low energy gamma-rays and measuring the intensity of K-shell X-rays emitted as a result of incoherent interaction of gamma-rays with K-shell electrons of the target as a function of the target thickness. It can be shown<sup>1</sup> that the ratio R of the intensity of K-shell X-rays emitted from targets of thickness  $2t$  and  $t$  when irradiated with gamma-rays is given by

$$R = 1 \div \exp. [-(\mu_\gamma + \mu_x)t / \cos \alpha]$$

where  $\mu_\gamma$  and  $\mu_x$  are the absorption coefficients of the target material for gamma-rays and fluorescent K-shell X-rays respectively, and  $\alpha = 45^\circ$  the angle of incidence for gamma-rays and angle of emergence for K-shell X-rays. Measuring R and  $t$  the value of  $\mu_\gamma + \mu_x$  can be determined. The values of  $\mu_\gamma$  are known<sup>2,3</sup> to an accuracy of better than 2%, the value of  $\mu_x$  can therefore be deduced. The results obtained by irradiating targets of lead, gold, tungsten, tin and silver with 145 keV gamma-rays from Ce-141 are compared in Table I

TABLE I  
Total attenuation coefficients below  
K-absorption edge in different elements

Element	K-edge energy <sup>†</sup> in keV.	X-ray energy <sup>†</sup> in keV.	Total attenuation coefficients (cm. <sup>2</sup> gm. <sup>-1</sup> )	
			Measured	Calculated
Lead ..	88.015	76.74	2.49 ± 0.12	2.40
Gold ..	80.726	70.45	2.67 ± 0.13	2.71
Tungsten ..	69.519	60.69	3.3 ± 0.17	3.23
Tin ..	29.201	25.78	9.91 ± 0.61	9.6
Silver ..	25.515	22.61	11.6 ± 0.8	11.8

with the available semi-empirical data<sup>3</sup> and are found to show good agreement with them. The present method may be usefully employed to obtain experimental data on absorption

coefficients in the vicinity of X-absorption edge where the available data are scanty.

The financial assistance from the Bhabha Atomic Research Centre, Trombay, Bombay, is gratefully acknowledged.

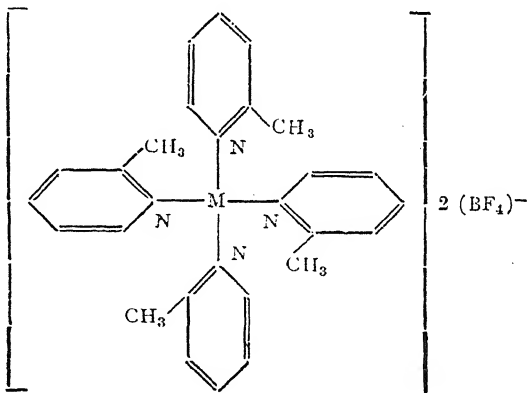
Physics Department,  
Punjabi University,  
Patiala-4, February 22, 1968.

B. S. GHUMMAN.  
B. S. SOOD.

1. Shute, G. G and Sood, B. S., *Proc. Roy. Soc.*, 1965, **257 A** 52
2. Grodstein, G. W., *NBS Circular*, 1957, **583**.
3. Hubbel, J. H. and Berger, M. J., *NBS Report*, 1966, **8681**.
4. Wapstra, A. H., Nijgh, G. J. and Van Lieshout R., *Nuclear Spectroscopy Tables*, North Holland Publishing Company, Amsterdam, 1959, Table 7, p. 2.

X-RAY DIFFRACTION DATA FOR  
SOME ORGANIC COMPOUNDS

I. THE tetra  $\alpha$ -pico M-fluoborates with the chemical formula  $M(C_6H_7N)_4(BF_4)_2$  and stereochemical formula



where  $M = Ni, Co, Zn$  or  $Cd$  are being studied presently in our laboratories using X-ray diffraction techniques.

The compounds are hygroscopic and vary in colour (green for Ni, pink for Co, white for Zn and grey for the Cd compound). Powder photographs were taken with a 9 cm. Unicam powder camera using Ni-filtered  $CuK\alpha$  radiation. The exposure was limited to four hours in each case. The powder data for the compounds are given in Table I.



TABLE I

X-ray diffraction powder data for tetra  
a-pico fluoroborates

Nickel		Cobalt		Zinc		Cadmium	
$d$ (Å)	$I/I_0$	$d$ (Å)	$I/I_0$	$d$ (Å)	$I/I_0$	$d$ (Å)	$I/I_0$
5.73	25	5.71	30	5.67	25	5.74	38
4.93	100	4.96	100	4.93	100	4.94	55
4.25	50	4.26	36	4.26	50	4.27	46
3.78	50	3.79	40	3.77	38	3.78	36
3.61	50	3.61	30	3.59	38	3.61	28
3.35	25	3.34	23	3.33	25	3.34	18
3.14	50	3.13	39	3.11	35	3.11	100
..	..	2.58	15	2.64	25	2.71	36
..	..	2.34	15	2.31	20	1.91	55
..	..	1.49	8	1.74	20	1.63	45
..	..	..	..	1.32	10	1.56	9
..	..	..	..	..	..	1.35	14
..	..	..	..	..	..	1.23	19
..	..	..	..	..	..	1.20	10
..	..	..	..	..	..	1.10	19
..	..	..	..	..	..	1.03	19
..	..	..	..	..	..	0.91	14
..	..	..	..	..	..	0.85	9

Since the ionic radii of Ni, Zn and Co are nearly the same (0.7-0.8 Å), it appears that replacement of Ni by Zn or Co still leaves the crystal structure unaltered with possibly nearly the same unit cell dimensions. The case, however is different with the Cd ion whose ionic radius is 1.0 Å.

II. The compound 2, 3-phenanthro, 4, 5-naphtho furan with the empirical chemical formula  $C_{24}H_{14}O$  is expected to show interesting features. The compound was available in the form of extremely thin and soft needles, orange-yellow in colour, with dimensions of needle  $0.4 \times 0.05 \times 0.05$  mm. Examined under the polarizing microscope extinction occurs parallel to the needle direction and the crystals exhibit greenish colour under crossed nicols.

Attempts to grow suitable single crystals from glacial acetic acid for structure analysis did not prove fruitful. However, one hair-like single crystal with extremely thin cross-section was selected from the crystallizing dish and mounted on a single crystal goniometer. A rotation photograph of the crystal with the axis of rotation parallel to the needle direction was taken. Due, probably to the extremely thin dimensions and large thermal vibrations, spots that were recorded on the equatorial and the first layer did not go beyond Bragg angle  $20^\circ$ .

From the measurement of the layer lines the identity period parallel to the needle direction was found to be 6.14 Å. As the specimen was extremely thin, long and very soft, it was not possible to mount the crystal in other orientations. A Weissenberg photograph with prolonged exposure gave very few spots. As the identity periods along other directions could not be determined, an attempt to determine the unit cell by combining the evidence from the powder and rotation photograph was made. The method followed was similar to that suggested by Henry and Lipson,<sup>1</sup> Ito<sup>3</sup> and Hesse.<sup>2</sup> By choosing the following values for the axial lengths and orthorhombic symmetry for the crystal all the powder lines could be explained satisfactorily.

$$a = 6.14 \text{ Å}, b = 18.80 \text{ Å}, c = 13.36 \text{ Å}.$$

The calculated density of the crystal is 1.37 gm./c.c. (volume of unit cell =  $1542.2 \text{ Å}^3$ , molecular weight of  $C_{24}H_{14}O = 318.35 \text{ a.m.u.}$  and number of molecules per unit cell = 4). The density measured by floatation method is 1.36 gm./c.c.

The linear absorption coefficient for  $CuK_\alpha = 1.542 \text{ Å}$ , is  $5.11 \text{ cm}^{-1}$ . The indexed powder data on the basis of the above unit cell are given in Table II. The assigned indices are too few to indicate the space group for the crystal.

TABLE II  
X-ray powder data for  $C_{24}H_{14}O$ 

$d_{\text{obs.}} \text{ Å}$	$d_{\text{calc.}} \text{ Å}$	$hkl$	$I/I_0$
9.41	9.40	020	68
6.69	6.68	002	10
5.60	5.58	101	8
5.21	5.15	120	10
4.65	4.70	040	100
4.39	4.40	112	5
4.22	4.17	131	47
3.73	3.73	140	34
3.59	3.60	103	34
3.32	3.34	004	8
2.95	2.94	211	39
2.70	2.70	231	3
2.55	2.56	063	5
2.41	2.40	242	3
2.15	2.16	261	8
2.01	2.01	311	8
1.91	1.92	331	3
1.84	1.85	313	8

III. (A) Pterocarpin, empirical chemical formula  $C_{17}H_{14}O_5$ , is a very soft substance, white in colour (m.p.  $164^\circ$ ). When examined under polarizing microscope, it appears in the form of extremely thin needles showing extinction parallel to the needle direction,

(B) Trimethyl brazilin, empirical chemical formula.  $C_{19}H_{15}O_5$  is a white substance of melting point  $139^\circ\text{C}$ . It crystallizes from alcohol. Examined under polarizing microscope, the compound appears in the form of extremely thin needles with extinction parallel to the needle direction.

(C) 5', 6' diethoxy - 2', 3' indeno isocoumarin, empirical chemical formula  $C_{20}H_{18}O_4$ , is cream-coloured, soft and hygroscopic. Like the other two compounds, this compound also appears in the form of extremely thin needles with extinction parallel to the needle direction under crossed nicols.

X-ray powder diffraction data for these compounds are given in Table III.

TABLE III  
X-ray powder data for  $C_{17}H_{14}O_5$ ,  
 $C_{11}H_{15}O_5$  and  $C_{20}H_{18}O_4$

Pterocarpin		Trimethyl brazilin		Indeno isocoumarin	
d <sub>obs.</sub> Å	I/I <sub>0</sub>	d <sub>obs.</sub> Å	I/I <sub>0</sub>	d <sub>obs.</sub> Å	I/I <sub>0</sub>
8.66	15	7.85	67	7.60	19
5.73	60	5.94	33	6.19	100
5.32	32	4.94	23	5.25	6
4.12	100	4.55	20	4.70	24
3.62	47	4.23	30	4.42	24
3.50	13	3.79	27	3.99	18
3.18	25	3.62	100	3.45	88
3.06	8	3.33	15	3.30	12
2.79	13	3.17	25	2.59	6
2.61	8	2.93	8	2.10	6
2.42	10	2.80	10	..	..
2.11	8	2.69	8	..	..
2.03	2	2.55	8	..	..
1.78	8	2.45	7	..	..
..	..	2.36	7	..	..
..	..	2.23	7	..	..
..	..	2.14	8	..	..
..	..	2.08	7	..	..
..	..	2.00	7	..	..
..	..	1.88	7	..	..
..	..	1.81	8	..	..
..	..	1.77	8	..	..
..	..	1.70	7	..	..
..	..	1.63	5	..	..
..	..	1.44	5	..	..
..	..	1.24	3	..	..
..	..	1.20	3	..	..

Dept. of Physics,  
Ranchi University,  
May 3, 1967.

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N. P. GUPTA.

- Henry, N. F. M. and Lipson, H., *The Interpretation of X-ray Diffraction Photographs*, Macmillan and Co. Ltd., London, 1960.
- Hesse, R., *Acta Cryst.*, 1948, 1, 200.
- Ito, T., *X-ray Studies on Polymorphism*, Tokyo. Maruzen, 1950.

### CORIOUS COUPLING COEFFICIENTS OF SQUARE PYRAMIDAL MOLECULES $\text{BrF}_5$ AND $\text{ClF}_5$

The infrared and Raman spectra of  $\text{BrF}_5$  and  $\text{ClF}_5$  have been studied earlier.<sup>1-5</sup> Recently, Begun and Fletcher<sup>6</sup> have studied the vibrational spectra and calculated the valence force constants. These molecules have the symmetry  $C_{4v}$  with  $3A_1 + 2B_1 + B_2 + 3E$  vibrations. The vibrational frequencies and the geometrical parameters used by Begun and Fletcher are used in the present investigation. The non-vanishing Coriolis coupling constants, for these molecules, arise from the couplings  $A_1 \times E$ ,  $B_1 \times B_2$ ,  $B_1 \times E$  and  $E \times E$ . After obtaining the C elements, the  $\zeta$  values are evaluated from the relation  $\zeta_\infty = L^{-1} C \infty \tilde{L}^{-1}$ , where L is the normal co-ordinate transformation matrix. The results are presented in Table I. It is found that for the  $B_1 \times B_2$  coupling  $(\zeta_{46}^2 + (\zeta_{56}^2)^2 = 1$  and for the  $E \times E$  coupling  $\sum_{i=7}^9 \zeta_i^2 = I_A/2I_B$  where I represents the moment of inertia.

TABLE I  
Coriolis coupling coefficients of  $\text{BrF}_5$  and  $\text{ClF}_5$

Coupling	$\zeta_{ij}^x$	$\text{BrF}_5$	$\text{ClF}_5$
$A_1 \times E$	$\zeta_{1,7b}^x = -\zeta_{1,7a}^y$	-0.4544	-0.7695
	$\zeta_{1,8b}^x = -\zeta_{1,8a}^y$	0.706	0.4660
	$\zeta_{1,9b}^x = -\zeta_{1,9a}^y$	-0.0070	-0.0015
	$\zeta_{2,7b}^x = -\zeta_{2,7a}^y$	0.0195	0.1480
	$\zeta_{2,8b}^x = -\zeta_{2,8a}^y$	-0.4350	-0.3203
	$\zeta_{2,9b}^x = -\zeta_{2,9a}^y$	0.1394	0.1139
	$\zeta_{3,7b}^x = -\zeta_{3,7a}^y$	-0.7033	-0.5466
	$\zeta_{3,8b}^x = -\zeta_{3,8a}^y$	-0.2616	-0.6288
	$\zeta_{3,9b}^x = -\zeta_{3,9a}^y$	0.6166	0.4718
$B_1 \times E$	$\zeta_{4,7a}^x = -\zeta_{4,7b}^y$	0.0783	0.1720
	$\zeta_{4,8a}^x = -\zeta_{4,8b}^y$	-0.3299	-0.2778
	$\zeta_{4,9a}^x = -\zeta_{4,9b}^y$	0.1691	0.1964
	$\zeta_{5,7a}^x = -\zeta_{5,7b}^y$	-0.5343	-0.2425
	$\zeta_{5,8a}^x = -\zeta_{5,8b}^y$	-0.3362	-0.4562
	$\zeta_{5,9a}^x = -\zeta_{5,9b}^y$	-0.7563	-0.3517

TABLE I (Contd.)

Coupling	$\xi_{ij}^z$	$\text{BrF}_5$	$\text{ClF}_5$
$B_2 \times E$	$\xi_{6,7b}^z = -\xi_{6,7a}^y$	-0.0492	-0.1480
	$\xi_{6,8b}^z = -\xi_{6,8a}^y$	0.3495	0.3202
	$\xi_{6,9b}^z = -\xi_{6,9a}^y$	-0.1280	-0.1139
$B_1 \times B_2$	$\xi_{36}^z$	0.9986	0.9954
	$\xi_{56}^z$	-0.0540	-0.0959
$E \times E$	$\xi_{7a,7b}^z$	0.4168	0.8236
	$\xi_{8a,8b}^z$	0.5026	0.4293
	$\xi_{9a,9b}^z$	-0.2008	-0.5276
	$\xi_{7a,8b}^z$	-0.3480	-0.1251
	$\xi_{7a,9b}^z$	-0.8349	-0.4800
	$\xi_{8a,9b}^z$	-0.4542	-0.6674

Dept. of Physics, K. VENKATESWARLU.  
Kerala Univ., MISS MARIAMMA P. MATHEW.  
Always-4, January 20, 1968.

- Burke, T. G. and Jones, E. A., *J. Chem. Phys.*, 1951, **19**, 1611.
- Mc Dowell, R. S. and Asprey, L. B., *Ibid.*, 1962, **37**, 165.
- Horak, J. P., *Master's Thesis*, Vanderbilt University, Physics Department, June 1962.
- Stephenson, C. V. and Jones, E. A., *J. Chem. Phys.*, 1952, **20**, 1830.
- Khanna, R. K., *J. Sci. & Ind. Res.*, 1962, **21 B**, 352.
- Begun, G. M. and Fletcher, W. H., *J. Chem. Phys.*, 1965, **42**, 2236.
- Lord, R. C. and Merrifield, R. E., *Ibid.*, 1952, **20**, 1348.

# RELAXATION TIMES AND DIPOLE MOMENTS OF ORTHO-, META- AND PARA-TOLUIDINES IN DILUTE SOLUTIONS AT 2.5 CM.

DIELECTRIC constants and dielectric losses have been determined for *ortho*-, *meta*- and *para*-toluidines in 2.5 cm. region at 25°C. In each case these values have been determined for four to five sets of dilute solutions in benzene. Experimental set up employed in the measurements is similar to that of Hiremath and Rao.<sup>1</sup> The relaxation times and dipole moments have been evaluated applying the

single frequency method of Gopalakrishna.<sup>2</sup> The activation energies for dielectric relaxation ( $H_T$ ) have been calculated using Eyring's relation.<sup>3</sup>

The *ortho*- and *para*-toluidines are of Riedel make and *meta*-toluidine is of B.D.H. All the three isomers are of Analar grade. The *ortho*- and *meta*-toluidines were dried over NaOH flakes, decanted and distilled, and middle fractions have been collected. The *para*-toluidine was first recrystallized in benzene and distilled under reduced pressure. The middle fraction was dried over NaOH flakes in a vacuum desiccator.

Table I gives relaxation times, dipole moments and activation energies for dielectric relaxation.

TABLE I

Substance	$\tau \times 10^{12}$ sec.	$\mu$ in debyes	$H_T$ in Kcal./mole
<i>o</i> -Toluidine	1.734	1.552	1.408
<i>m</i> - "	1.896	1.754	1.472
<i>p</i> - "	2.273	2.185	1.569

It is observed that the relaxation times and dipole moments increase from *ortho*- to *para*-through *meta*-isomer and hence it might be inferred that the molecule rotates as a single unit.

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Dept. of Physics, B. S. SARMA.  
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College,  
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February 7, 1968.

- Hiremath, G. C. and Suryanarayana Rao, K., *Ind. J. Phys.*, 1964, **38**, 194.
- Gopalakrishna, K. V., *Trans. Far. Soc.*, 1957, **53**, 767.
- Eyring, H., Glasstone, S. and Laidler, K. J., *The Theory of Rate Process*, McGraw-Hill Book Co., Inc, New York, 1941, p. 548.

## <sup>35</sup>Cl AND <sup>69</sup>Ga NQR SPECTRA OF (C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>O.GaCl<sub>3</sub> COMPLEX\*

RECENTLY the far-infrared spectrum<sup>1</sup> of the liquid (C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>O.GaCl<sub>3</sub> complex has been interpreted in terms of a monomer structure with C<sub>3v</sub> symmetry. The <sup>35</sup>Cl NQR spectrum of the (C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>O.GaCl<sub>3</sub> complex is presented below to show that the molecule has lower symmetry than C<sub>3v</sub> in the solid state.

The resonance signals were searched in the range 12.5 to 28.5 Mc./s. at 77° K. The NQR signals found were  $^{35}\text{Cl}$  17.852 Mc./s., 17.579 Mc./s. and 17.392 Mc./s. (triplet) and  $^{69}\text{Ga}$  15.992 Mc./s. and 15.948 Mc./s. (very broad, could be a singlet).

There were no trace of  $^{35}\text{Cl}$  signal near 14.7 Mc./s. the position at which the bridge chlorines occur in  $\text{Ga}_2\text{Cl}_6$ ,<sup>2</sup> and therefore the possibility of five co-ordinate dimer complex,  $2(\text{C}_2\text{H}_5)_2\text{O} \cdot \text{Ga}_2\text{Cl}_6$ , is ruled out. The  $^{35}\text{Cl}$  signal showing triplet seems to favour the presence of  $\text{GaCl}_3$  unit in the  $(\text{C}_2\text{H}_5)_2\text{O} \cdot \text{GaCl}_3$ . The three chlorine atoms attached to gallium in the molecule of  $(\text{C}_2\text{H}_5)_2\text{O} \cdot \text{GaCl}_3$  are in different environments and therefore give their characteristic signals. This arises because of their different spacial arrangement relative to the lone pair of electrons and the two ethyl groups at the oxygen atoms of ether and secondly because of a "solid state" effect, thus explaining the lowering of the symmetry from  $\text{C}_{2v}$  to  $\text{C}_1$ .

The apparatus used for  $^{35}\text{Cl}$  and  $^{69}\text{Ga}$  NQR spectra has been described by Smith and Tong.<sup>3</sup> The preparation of the complex is described elsewhere.<sup>4</sup>

I am grateful to Dr. J. A. S. Smith for the discussion of the results and to Dr. D. A. Tong (University of Leeds) for running the NQR spectra.

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Bombay-74, February 21, 1968.

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1. Greenwood, N. N., Srivastava, T. S. and Straughan, B. P., *J. Chem. Soc. (A)*, 1966, p. 699.
2. Dehmelt, H., *Phys. Rev.*, 1953, **92**, 1240.
3. Smith, J. A. S. and Tong, D. A., *Chem. Comm.*, 1966, p. 3.
4. Greenwood, N. N. and Srivastava, T. S., *J. Chem. Soc. (A)*, 1966, p. 270.

#### PREPARATION AND ABSORPTION SPECTRUM STUDIES OF LANTHANUM 5-NITRO-OROTIC ACID COMPLEX

STABLE complexes of 5 substituted orotic acid with  $\text{Cu(II)}$ ,  $\text{Ni(II)}$ ,  $\text{Co(II)}$ ,  $\text{Zn(II)}$ ,  $\text{Cd(II)}$ , and  $\text{Mn(II)}$  have been reported.<sup>1,2</sup> It was postulated<sup>3</sup> that in 5-nitro orotic acid the complex formation has occurred through the carboxylate ion and the adjacent nitrogen. Some preliminary data regarding the preparation and characterisation of lanthanum 5-nitro-orotate are reported in this communication.

A weighed amount of lanthanum oxide was dissolved in A.R. grade hydrochloric acid and the resulting solution was evaporated to dryness on steam bath. The residue was extracted with 20 ml. of absolute alcohol and a calculated amount (mole ratio 1:3) of the potassium salt of 5-nitro-orotic acid in 25 ml. of water alcohol mixture (20 ml. of absolute alcohol and 5 ml. of water) was added. The solution was filtered, washed with methanol and vacuum dried for 48 hours over fused calcium chloride. A weighed amount of the dried chelate was ignited in a platinum crucible and the residual oxide weighed. The metal to ligand ratio was found as 1:3. [Found metal 19.9% ;  $\text{La}(\text{C}_5\text{H}_2\text{O}_6\text{N}_3)_3$  requires 18.9%].

The absorption spectra in the visible and ultraviolet regions were recorded using Unicam SP 500 spectrophotometer, and in the infra-red region using a Perkin-Elmer model 137 Infracord. The solid was examined as nujol mull.

The ultraviolet absorption spectra of orotic acid and substituted orotic acids have been extensively investigated.<sup>1,2</sup> Tucci *et al.*<sup>2</sup> have reported one absorption maximum at 338  $\text{m}\mu$  for 5-nitro orotic acid at pH 7, assigned to the uracil keto band. In our investigation (solvent: water) a band is obtained at 336  $\text{m}\mu$  ( $\epsilon = 10,300$ ) for the potassium salt of 5-nitro orotic acid. However, the uracil keto band was located in the lanthanum complex at 331  $\text{m}\mu$  ( $\epsilon = 24,170$ ). There is an enhancement in the  $\epsilon$  value. A band is located at 235  $\text{m}\mu$  ( $\epsilon = 18,220$ ) in the complex, whereas no such absorption is obtained in the free ligand.

The absorption spectrum of the ligand in the visible region indicates no selective absorption.

The infra-red spectra of pyrimidine and substituted pyrimidines were recorded by Brownlie<sup>4</sup> and Short and Thompson.<sup>5</sup> In a study of the 5-nitro uracil they observed two strong bands in the region 1670  $\text{cm}^{-1}$ -1740  $\text{cm}^{-1}$  and a third band near 1639  $\text{cm}^{-1}$ .

In the 5-nitro orotic acid (potassium salt) a weak band was located at 3250  $\text{cm}^{-1}$  and this could be assigned to the N-H stretch frequency. A band around 1625  $\text{cm}^{-1}$  is located in the ligand and this could be assigned to the  $\text{C}=\text{O}$  frequency, of the lactam form. The two bands observed at 1690  $\text{cm}^{-1}$  and 1725  $\text{cm}^{-1}$  agree well with the observations made by Thompson for 5-nitro uracil. However one could assign

the 1690  $\text{cm}^{-1}$  band to the  $\text{C}=\text{O}$  stretch which might arise due to the presence of a carboxyl group in the ligand now used.

Also in lanthanum chelate were observed (i) a broad band between 3400–3600  $\text{cm}^{-1}$  N-H stretch, (ii) a broad band between 1700–1650  $\text{cm}^{-1}$  ( $\text{C}=\text{O}$  of the carboxyl group) and (iii) a sharp band of low intensity at 1640  $\text{cm}^{-1}$ .

From all the above observations it may be tentatively concluded that the complexation has occurred through the  $\text{N}_1$  nitrogen and the adjacent carboxylate ion.

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Marathwada Univ., V. RAMACHANDRA RAO.  
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October 17, 1967.

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1. Tucci, F. R., Takahashi, F. and Tucci, V. A., *J. Inorg. Nucl. Chem.*, 1964, **26**, 1253.
2. — and Li, N. C., *Ibid.*, 1963, **25**, 17.
3. —, Doody, E. and Li, N. C., *J. Phys. Chem.*, 1961, **65**, 1570.
4. Brownlie, I. A., *J. Chem. Soc.*, 1950, p. 3062.
5. Short, L. N. and Thompson, H. W., *Ibid.*, 1952, p. 168.

### VOLUMETRIC ESTIMATION OF VANADIUM (V)—A NEWLY SUGGESTED PROCEDURE

THE conventional method of estimation of vanadium (V) is with standard ferrous ammonium sulphate in phosphoric acid-sulphuric acid mixtures using an internal redox indicator such as barium diphenylamine sulphonate.<sup>1</sup> An extension of the method in kinetic studies is to run down a known amount of V(V) into a known excess of standard Mohr's salt solution and to titrate the unreacted ferrous ammonium sulphate against a standard solution of V(V). During a kinetic study of the oxidation of secondary alcohols by V(V), we found that this method was unsuitable when extremely dilute solutions of V(V) (of the order of 0.002 M) were employed. The end point was either diffuse or could not be determined at all even in the presence of an increased amount of the indicator and the phosphoric acid-sulphuric acid mixture.

A review of the oxidation potentials<sup>2</sup> of the various systems involved, suggested to us that the excess ferrous ammonium sulphate could as well be estimated by a dilute solution of standard potassium dichromate ( $\sim 0.006$  M). The apparent disadvantage of this method seems to be that potassium dichromate might also oxidise V(IV) to V(V). Fortunately, this does not take place because the indicator gets oxidised prior to the oxidation of V(IV).

Our experimental procedure is as follows. A series of standard V(V) solutions were prepared using ammonium metavanadate (Reidel) in sulphuric acid. Analar Mohr's salt and potassium dichromate were the other standards used. A 0.3% solution of barium diphenylamine sulphonate (B.D.H.) was used as the indicator. 10 ml. of a mixture of phosphoric acid and sulphuric acid (10%  $\text{H}_3\text{PO}_4$ ; 4 M  $\text{H}_2\text{SO}_4$ ) was used for each titration.

The estimations were carried out by pipetting out 5 ml. of the V(V) solution to be estimated into 5 ml. of standard Mohr's salt solution (0.035 M) containing 10 ml. of the phosphoric acid-sulphuric acid mixture and titrating the contents against standard  $\text{K}_2\text{Cr}_2\text{O}_7$ .

The results are presented in Table I.

TABLE I  
Strength of standard V(V) to be estimated  
= 0.02215 M

Strength of titrant $\text{K}_2\text{Cr}_2\text{O}_7$	Nature of the end point	Estimated value of V (V)
0.099470 N	Sharp (blue to violet)	0.02288* M
0.049370 N		0.02211 M
0.031580 N		0.02111 M
0.005853 N		0.02217 M

\* A large error due to high concentration of the dichromate.

We wish to report that this modified method is especially suitable in oxidation kinetics where low concentrations of V(V) have to be estimated.

Dept. of Chemistry, N. VENKATASUBRAMANIAN.  
Vivekananda College, B. GANAPATHYSUNDARAM.  
Mylapore, Madras-4,  
January 11, 1968.

1. Turney, T. A., *Oxidation Mechanisms*. Butterworths, London, 1965.
2. Latimer, W. M., *Oxidation Potentials*, Prentice-Hall, New York, 1943.

# POTASSIUM AND SODIUM DISTRIBUTION IN ERYTHROCYTE AND PLASMA OF BUFFALO COWS

POLYMORPHISM with respect to the concentration of K and Na in the erythrocyte had been recognized in sheep<sup>1</sup> and cattle.<sup>2</sup> The study under report on the distribution of K and Na in the erythrocyte and plasma of buffaloes shows similar polymorphism. With respect to erythrocyte K content, 57.5% of the herd belonged to high K (HK) type with a concentration of  $74.71 \pm 1.66$  mEq./l, while 42.5% had lower erythrocyte K content (LK) with a concentration of  $41.61 \pm 0.95$  mEq./l. The difference in the values of the two population was found significant at  $P < 0.01$ . The Na distribution in erythrocyte varied in the two types in opposite direction, being low ( $28.15 \pm 1.27$  mEq./l) in HK type and higher ( $39.25 \pm 2.65$  mEq./l) in LK type. The concentration of the two electrolytes in the plasma, however, did not show any significant difference; being  $5.10 \pm 0.08$  mEq./l and  $150.31 \pm 1.95$  mEq./l in HK type; and  $5.17 \pm 0.12$  mEq./l and  $148.17 \pm 1.60$  mEq./l in LK for K and Na respectively. There appears to be a basic difference in the erythrocyte K and Na polymorphism between buffalo and cattle,<sup>2</sup> concentration being higher for K and lower for Na in the former.

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U.P. College of Veterinary  
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Husbandry, Mathura (India),  
February 10, 1968.

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A. ROY.

1. Ogden, A. L. *Anim. Breed Abstr.*, 1961, 29, 127.
2. Evans J. V., *Aust. J. Agric. Res.*, 1963, 14, 559.

# PRODUCTION OF CELLULASE FOR PROCESSING GROUNDNUT CAKE

GROUNDNUT is rich in protein and so, apart from oil, the cake, if properly processed, could be used for human consumption. Formula has been standardised at CFTRI, Mysore, India, for the preparation of toned milk using groundnut protein isolate.<sup>1</sup> The residue left behind after protein isolation accounts to about 30% on dry matter basis, and contains 30-33% protein and 3-8% crude fibre. A suitable enzyme system, if developed for the hydrolysis of fibre and polysaccharides, will not only increase protein recovery but also yield mono and disaccharides needed for toned milk prepara-

tion. Since technical details are not available for enzymic processing of groundnut cake for human consumption, attempts are being made in this Institute to develop such an enzyme for processing the same. The present report outlines the preliminary investigations.

Fungi are the most promising source of cellulase and related enzymes. Six cellulolytic moulds, *Pestalotiopsis westerdijkii*: Q.M. 381 (P.W.), *Basidiomycete* (conidia stage): Q.M. 806 (B); *Syrotichum pruinosum*: Q.M. 826 (S.P.); *Trichoderma viride*: Q.M. 6a (T.V.), *Myrothecium verrucaria*: Q.M. 460 (M.V.) and *Chaetomium globosum* 874 (C.G.) were used in the present studies.

Aluminium trays containing wheat bran, wheat bran saw-dust, and wheat-bran groundnut flour as supporting media, moistened with the mineral salt solution of Mandel's and Reese<sup>2</sup> were sterilised and inoculated with spore suspension of the above moulds. After 10 days' incubation at 28° C., the enzyme was extracted with five folds of distilled water at room temperature (28° C.). 30% saturation of ammonium sulphate helped to remove extraneous materials, and insoluble proteins. The clear supernatant was used as crude enzyme in the following experiments. One gm. groundnut residue samples<sup>1</sup> were treated with 40 ml. of enzyme at pH 6.0 and 40° C. for 6 hours, after which the contents were filtered and washed thoroughly. The filtrates and washings were mixed together and aliquots were drawn to estimate the protein content.<sup>3</sup> Necessary corrections were made for enzyme nitrogen. The increase in protein extraction by enzymic treatment of groundnut residue indirectly indicates the hydrolysis of structural polysaccharides and thus the release of the internal contents of the cells. So the yardstick to measure the potency of an enzyme preparation in the present studies is the ability of the enzyme to cause significant improvement in protein extraction.

It is evident from Table I that *T. viride* and *S. pruinosum* had elaborated more potent enzyme than others. Wheat-bran served as a good substrate compared to other supporting media for enzyme production. *P. westerdijkii*, an active cellulase-producing organism, did not cause much improvement in protein extraction from groundnut residue.<sup>4</sup> Wherever wheat-bran and groundnut flour were used as supporting media no increase in the percentage of protein extraction was noticed. This suggests that the presence of groundnut flour in

the medium in no way helps in the production of active enzyme. All the fungi grew luxuriously on wheat-bran medium. The growth was scanty on the other two media.

TABLE I

Efficiency of different enzyme preparation in protein extraction from groundnut residue

Organism	Protein extraction (%)		Dry matter extraction (%)	
	1	2	1	2
TV ..	68.70	28.80	61.11	58.58
M.V. ..	30.80	43.80	57.05	51.12
S.P. ..	72.90	53.90	59.35	58.46
B ..	27.20	39.60	51.90	58.41
P.W. ..	32.66	30.40	57.04	50.70
C.G. ..	25.00	..	56.40	59.10
Control	24.20	..	38.70	..

1 Wheat-bran, 2 Wheat-bran + Saw-dust.

Since all the moulds are supposed to be cellulolytic, the enzyme samples were used to study their ability to degrade filter-paper and pure cellulose powder. 100 mgm. samples of the above cellulosic materials were treated with various enzyme preparations at room temperature for 24 hrs. and the reducing sugars liberated were estimated.<sup>5</sup> The results are shown in Table II. Enzyme prepared from *T. viride*, *M. verrucaria*, *S. pruinosa* and

TABLE II

Degradation of filter-paper and pure cellulose by different enzyme samples  
Total reducing sugar units/tray

Organism	Filter-paper		Cellulose powder	
	1	2	1	2
TV ..	1081.6	140.0	1779.2	494.0
M.V. ..	1840.8	676.8	1341.6	889.2
S.P. ..	1918.8	93.0	486.0	1686.0
B ..	..	..	..	..
P.W. ..	1796.4	870.4	2595.6	561.0
C.G. ..	844.8	365.0	782.4	1645.0

1 Wheat-bran, 2 Wheat-bran + Saw-dust.

*P. westerdijkii* hydrolysed not only filter-paper but also the pure cellulose. Here again the superiority of wheat-bran as supporting medium for enhancing the potency of enzyme became abundantly clear. This table also reveals that the enzyme preparation of *M. verrucaria* and *P. westerdijkii* are indeed very active against cellulosic materials. The reason for poor extraction of protein from groundnut residue by these enzymes might therefore be due to the interference of other polysaccharides present in the residue. Evidences in support of this assumption are available in reports which show that

the association of lignin with plant tissues considerably decreases the enzymic degradation of cellulose.<sup>6,7</sup>

The authors are thankful to Dr. H. A. B. Parpia, Director, C.F.T.R.I., for kindly suggesting the problem, Dr. T. N. Ramachandra Rao, for his keen interest in the work, and Dr. E. T. Reese for supply of the cultures.

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Discipline of Microbiology,  
Central Food Tech. Res. Inst.,  
Mysore-2, February 22, 1968.

1. Bhatia, D. S., Parpia, H. A. B. and Baliga, B. P., *J. Food Sci. and Tech.*, 1966, **3**, 2.
2. Mandels, M. and Reese, E. T., *J. Bacteriol.*, 1957, **73**, 269.
3. Chandrasekaran, A. and King, K. W., *J. Agril. and Food Chem.*, 1967, **15**, 305.
4. —, *Curr. Sci.*, 1967, **36**, 297.
5. Nelson, N., *J. Biol. Chem.*, 1944, **153**, 375.
6. Basu, S. N. and Ghose, S. N., *J. Text. Inst.*, 1952, **43**, 278.
7. Ramamurti, K. and Johar, D. S., *Nature*, 1963, **198**, 481.

### STERILIZING EFFECT OF A PHOSPHORAMIDE ON *CULEX FATIGANS* WEID.

STERILIZATION of harmful insects by chemosterilants in insect control programmes is now well established. The non-alkylating chemosterilant, hexamethylphosphoramide (HEMPA) was found to cause significant sterility in the mosquito, *Culex fatigans* Weid. when treated either in the larval or pupal stages.<sup>1</sup> This important finding has led us to investigate other phosphoramides, structurally related to HEMPA as possible chemosterilant against this mosquito.

The phosphoramide employed in the present study was N, N, N', N'-tetramethyl-P-piperidino-phosphonic diamide (ENT. 51007).<sup>2</sup> Like HEMPA, ENT. 51007 is water-soluble and is only moderately toxic to mammals. *C. fatigans* strain used in the present study originated from the same colony employed in our previous studies.<sup>1</sup> Only larvae were exposed to various concentrations of the phosphoramide and the sterilizing effect was assessed by the same methodology of Grower *et al.*<sup>1</sup> In the present study, mortality at various stages of the surviving offspring (F<sub>1</sub>) was also estimated.

Table I shows the toxicity and the sterilizing effect of the phosphoramide ENT. 51007. The

TABLE I  
Effect of ENT. 51007 on the mortality,  
oviposition and egg hatch of *C. fatigans*

Compound	Conc. in ppm.	% mortality	No. of egg rafts	No. of eggs	% hatch	% sterility	% mortality in F <sub>1</sub> survivals
ENT. 51007 ..	100	6	11	596	40.2	59.8	20.0
	250	77	4	312	32.3	67.7	40.0
	500	100	..	..	..	..	..
Control ..	...	6	14	2151	98.5	1.5	2.0

compound was found to be almost as toxic as HEMPA and caused considerable reduction in oviposition. One notable finding of the present investigation is that ENT. 51007 induced 59.8% sterility with 100 ppm. while the same concentration of HEMPA caused only 50% sterility.<sup>1</sup> It is also interesting to note that while ENT. 51007 proved to be highly effective against *C. fatigans* it was less effective than HEMPA against house-flies.<sup>2</sup> The sterilizing property of non-alkylating chemosterilants appears to be specific as compared to alkylating aziridines.<sup>1</sup> The F<sub>1</sub> offspring showed significant mortality at various stages. This property adds to its utility as an effective chemosterilant in any control programme against *C. fatigans*.

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Department of Zoology, M. K. K. PILLAI.  
University of Delhi, K. K. GROVER.  
Delhi-7, March 4, 1968.

1. Grover, K. K., Pillai, M. K. K. and Dass, C. M. S., *Curr. Sci. (India)*, 1967, **36**, 625.
2. Terry, P. H. and Borkovec, A. B., *J. Med. Chem.*, 1967, **10**, 118.

# CHANGES IN AMINO-ACID CONTENT OF CUCUMBER (*CUCUMIS SATIVUS* L.) LEAVES INFECTED WITH *PSEUDOMONAS LACHRYMANS* (SMITH AND BRYAN) CARNSER.

ANGULAR leaf spot of cucumber (*Cucumis sativus* L.) incited by *Pseudomonas lachrymans* (Smith and Bryan) Carsner. is a very destructive disease of cucumber. The leaves show transparent, round or irregularly shaped distinctly angular spots which under favourable

humidity can extend along the veins and coalesce to cover the entire leaf. On the spots on the underside of the leaf, especially in the early hours of the morning, droplets of bacterial slime appear, which in dry weather dry out into a white incrustation. Later the necrotic lesions drop out, leaving a ragged shot-holed appearance to the leaves.

It has been reported that varieties differ in reaction to this organism.<sup>1</sup> The present report concerns the studies on the changes caused by the pathogen in the amino-acid content of the resistant and susceptible plants.

Cucumber plants were raised from healthy seeds of SMR-18 (susceptible) and PI-400 (resistant) in vermiculite and uniform seedlings were transplanted to quartz sand in 5 inch earthen pots and supplied with Hoagland nutrient solution at an interval of 3-5 days. When the plants were in 6-leaf stage the leaves were surface-sterilized and inoculated with a pure culture of *P. lachrymans* following the usual procedure. The inoculated and check plants were maintained under humid conditions. Disease symptoms in the form of water-soaked lesions appeared after 2 days. Soaked lesions turned into characteristic angular spots in 3-4 days. The pathogen could be readily isolated from these spots and on comparison it was found identical with the inoculum. Five days after inoculation the youngest leaves (inoculated and healthy) of both the varieties were removed from the plants and analysed for free amino-acids by two-dimensional paper chromatographic technique followed by Thompson and Morris.<sup>5</sup> The results are summarized in Table I.

TABLE I  
Amino-acids in healthy and diseased leaves of  
cucumber (*Cucumis sativus* L.)

Amino-acids	Healthy leaf		Diseased leaf	
	PI-400	SMR-18	PI-400	SMR-18
Alanine	.. 1.0	2.5	1.5	3.0
Glutamic acid	.. 2.5	3.5	2.5	4.0
Valine	.. Trace	Trace	Trace	Trace
Leucine	.. "	"	"	"
Pipecolic acid	.. 2.0	3.0	3.5	5.0
γ-aminobutyric acid	1.75	2.0	1.0	1.0
Proline	.. 0.75	0.75	1.0	1.5
Glycine	.. 0.25	0.50	0.50	1.0
Serine	.. 0.5	0.75	0.75	1.0
Aspartic acid	.. 1.5	2.75	1.00	3.50
Asparagine	.. Trace	Trace	0.5	2.5
Arginine	.. "	0.5	0.5	0.5
Citrulline	.. 1.0	1.0	1.25	2.0
Threonine	.. Trace	Trace	Trace	Trace
Lysine	.. 0.25	..	0.5	0.75



Both the resistant and susceptible lines contained 15 ninhydrin positive amino-acids and amides each. In the susceptible leaves pipelicolic acid, aspartic acid, alanine and glutamic acid were more than in the resistant leaves. When the plants were inoculated with the culture of *P. lachrymans*, the susceptible plants showed marked increase in pipelicolic acid, glutamic acid, aspartic acid and asparagine over the resistant inoculated plants.

Changes in amino-acids following infection of some other plant tissues have been reported by other workers.<sup>3</sup> The possibility of amino-acids being transported to the site of infection and subsequent utilization by the pathogen has been suggested by McCombs and Winstead.<sup>4</sup>

The author is highly thankful to Prof. J. C. Walker, Professor Emeritus, University of Wisconsin, for the keen interest in the studies and for his valuable suggestions.

Dept. of Botany and J. N. CHAND.

Plant Pathology,  
Punjab Agric. University,  
Hissar, Haryana, September 16, 1967.

1. Chand, J. N. and Walker, J. C., *Phytopathology*, 1964, 54, 51.
2. Hanks, R. W. and Feldman, A. W., *Ibid.*, 1966, 56, 261.
3. Hrushovetz S. B., *Canad. J. Bot.*, 1964, 32, 571.
4. McCombs, C. L. and Winstead, N. N., *Phytopathology*, 1964, 54, 233.
5. Thompson, J. F. and Morris, C. J., *Ann. Chem.*, 1959, 31, 1031.

#### INDUCTION OF FLOWERING IN *ANAGALLIS ARVENSIS* VAR. *COERULEA* BY GIBBERELIC ACID

With the establishment of the gibberellins as natural growth regulators in plants they were supposed to be the endogenous controls of flowering.<sup>1-3</sup> The stimulation of flowering with gibberellin can be assigned to two groups of plants, those that are caused to flower by low temperature and the long-day plants.<sup>4</sup> *Anagallis arvensis* is a long-day plant<sup>5</sup> and, therefore, the present investigation was undertaken to ascertain if flowering in this species could be induced by application of gibberellic acid.

Seeds of *Anagallis arvensis*, collected from a wheat field, were sown in 15 cm. earthen pots filled with a mixture of garden soil and compost (3 + 1). All the pots were exposed to natural light for 8 hours (non-inductive photoperiod) daily. Seedlings were thinned in each pot after 20 days and different concentrations of gibberellic acid were applied through foliar

spray. After gibberellic acid treatment, the pots were divided into two groups; one was maintained under non-inductive 8 hours photoperiod, while the other was given 15 hours inductive photoperiod. Inductive photoperiod included 5 hours of supplemental artificial light provided by a 200-watt incandescent lamp placed at a distance of 1 m. above the plant surface. The gibberellic acid treatment was repeated after one week.

Increase in the height of the plants is somewhat proportional to increase in concentration of gibberellic acid from 100 to 1,000 p.p.m., (Fig. 1). Plant height is affected almost to

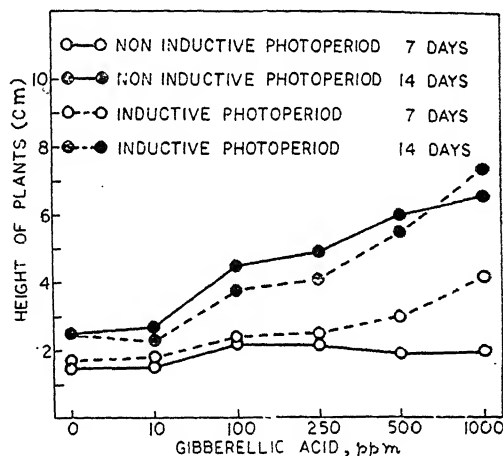


FIG. 1

the same extent by gibberellic acid in non-inductive as well as inductive photoperiods. Increase in height is more after second application in both the cases.

Earliest visible floral bud was recorded after 3-5 days in plants treated with 100 p.p.m. gibberellic acid and kept under non-inductive photoperiod; whereas under inductive photoperiod it appeared in 500 p.p.m. treatment (Table 1). More time was required with other

TABLE I  
Days required for visible floral bud initiation  
after application of gibberellic acid in  
*Anagallis arvensis* seedlings

Concentration p p m.	Short-day (8 hrs)	Long-day (15 hrs.)
0	..	5
10	6	5
100	3	5
250	4	4
500	4	3
1,000	5	4

concentrations and especially under inductive photoperiod time requirement for control, 10 and 100 p.p.m. treatments was the same.

It is evident (Fig. 2) that 10 p.p.m. gibberellic acid can induce flowers under non-inductive photoperiod, but the maximum flowering is observed at 100 p.p.m. However, the num-

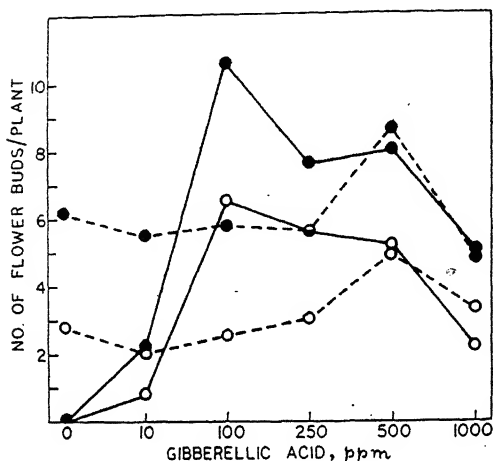


FIG. 2 (Legend same as in Fig. 1).

ber of flowers is reduced with increasing concentration. Under inductive photoperiod, all concentrations of gibberellic acid produce almost the same number of flowers, except 500 p.p.m. concentration which produces more number. Capsule development occurs between 7-14 days in plants treated with 500 and 1,000 p.p.m. gibberellic acid. Mean number of capsules per plant was 2.6 and 2.0 at 500 and 1,000 p.p.m. treatments, respectively.

The long-day species, which are induced to flower by gibberellins are invariably rosette plants which shoot or bolt before flowering; species which are long-day plants and not rosette in form do not flower in response to gibberellin.<sup>4</sup> However, flowering in *Anagallis arvensis*, which is an erect plant, is induced by gibberellic acid under non-inductive photoperiod, and gibberellic acid appears to be able to completely replace the long-day requirement for flowering in this species. It may be pointed out that under non-inductive photoperiod internode length of this species is highly reduced, but after gibberellic acid or inductive photoperiod treatments there is a sudden increase in internode length of the plant.

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Department of Botany, K. P. SINGH.  
Banaras Hindu University,  
Varanasi (India), February 21, 1968.

1. Lang, A., *Naturwissenschaften*, 1956, 23, 544.
2. —, *Proc. Nat. Acad. Sci., U.S.*, 1957, 43, 709.
3. — and Reinhard, E., *Advan. Chem. Ser.*, 1961, 28, 71.
4. Leopold, C. A., *Plant Growth and Development*, McGraw-Hill, 1964.
5. Singh, K. P., *P.L. 480 Ecology Research Project—Annual Report*, 1967, p. 87.

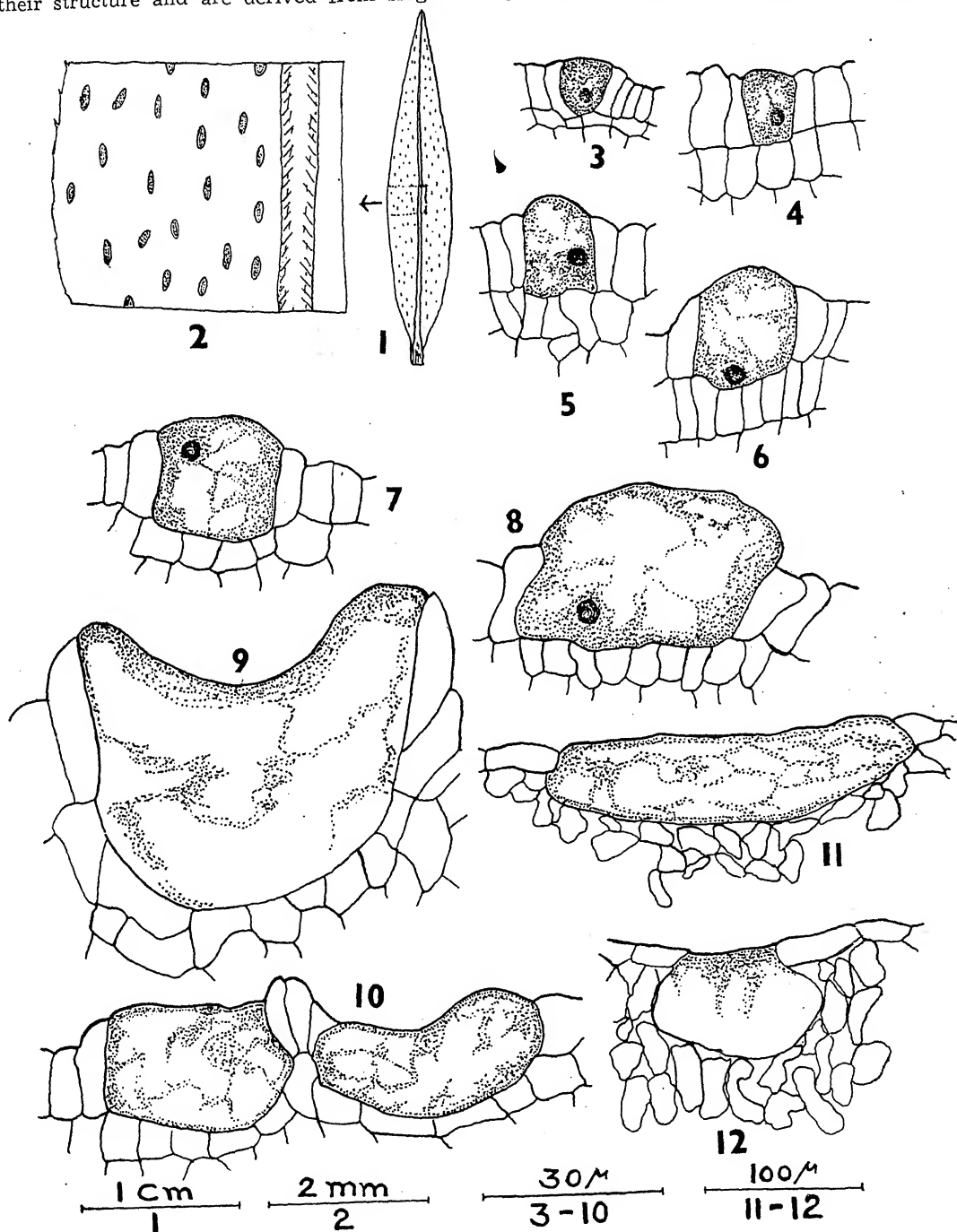
#### OCCURRENCE OF IDIOBLASTIC CELL-SACS IN THE LEAF EPIDERMIS OF *CLEOME ASPERA* KOEN. EX DC., WITH OBSERVATIONS ON THEIR TAXONOMIC SIGNIFICANCE, STRUCTURE AND DEVELOPMENT

IDIOBLASTIC cell elements of flowering plants are of several kinds and they have been often of taxonomic importance, e.g., the trichosclereids<sup>1</sup> in *Monstera*; secretory cells<sup>2</sup> in Euphorbiaceae; lithocysts in Cucurbitaceae, Acanthaceae and Urticaceae and mucilage cells<sup>3</sup> in Lythraceae, Euphorbiaceae and Chenopodiaceae. The present authors, in the course of their studies on the "Flora of Hyderabad", have observed cavity-like structures in the leaves of *Cleome aspera* Koen. ex DC. These are visible when seen with a pocket lens and hence the species is readily distinguished in the field merely by its leaves from the allied members of *C. viscosa* L., *C. monophylla* L., *C. chelidoni* L. and *C. felina* L.f. *Cleome aspera* has a wide distribution both in India<sup>4-5</sup> and outside,<sup>5-7</sup> but as far as the authors are aware, the said character has not been described in the past. Due to the taxonomic value of these cavities, their structure and development also have been studied which are as follows:

The cavities are ovoid to oblong in outline (0.05-0.15 × 0.01-0.03 mm.), rounded at both ends and appear as dark green spots under pocket lens. They are distributed with their longitudinal axis oriented mostly parallel to the midrib (Fig. 2) and are confined to only the leaf-lamina. The other parts like the midrib, veins, stem and flowers are devoid of them. In sectional views, they appear like large cavities and show granular contents (Figs. 10 & 11). The cavities are epidermal in their position, but intrude into the mesophyll

due to their greater thickness. As shown from the ontogeny (see below), they are unicellular in their structure and are derived from single

protoderm initials (Fig. 3). Thus morphologically they are homologous to several of the single-celled idioblastic epidermal elements



FIGS. 1-12. *Clome aspera*. Fig. 1. A leaflet with cell-sacs. Fig. 2. Enlarged surface view of cell-sacs. Figs. 3-10. Developmental stages of the cell-sac (all from t.s. of leaf). Fig. 11. Mature cell-sac as seen in l.s. of a leaflet. Fig. 12. Mature cell-sac as seen in t.s. of a leaflet.

such as the mucilage cells in Lythraceae and secretory cells in Euphorbiaceae. The granular contents take up red colour when treated with ruthenium red indicating their pectinate nature. The wall is devoid of lignin as it is negative to aniline sulphate and phloroglucin tests. Due to their unicellular nature they are called as "cell-sacs".

The cell-sacs develop from single protoderm initials. The latter differentiate at about the same time as the primordia of the prickles which are a characteristic feature of this plant. The initials are recognised due to their dense cytoplasmic contents and larger size of the nucleus from the surrounding cells (Fig. 3). As they enlarge their contents become thinner and the vacuoles become conspicuous (Figs. 4-9). The nucleus is usually parietal in its position. As seen in Figs. 3-8, the outer wall of the cell-sac, in the early phase of development, is relatively swollen and appears protruded above the epidermis. But when fully developed, it becomes shrunken. By this time the contents become sparse and the nucleus degenerates. Sometimes the sacs differentiate very close to each other and hence appear in pairs (Fig. 10).

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## A PRELIMINARY STUDY ON THE CHROMOSOMES OF *TILAPIA* *MOSSAMBICA* (PETERS)

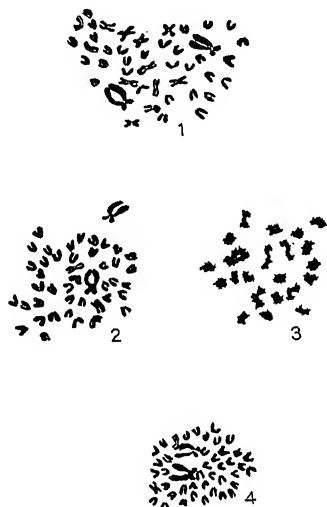
DETAILED karyotypic analysis supplemented by morphological data on adult specimens could undoubtedly throw light on problems of fish taxonomy and phylogeny. However, the recent report of Ohno *et al.* (1965)<sup>1</sup> underlines clearly the fact that only comparative studies on the chromosomes of fishes from somatic as well as germ-cells are preferable. The present note outlines an attempt in this direction.

The methods described by Roberts (1964)<sup>2</sup> and by Macphail *et al.* (1966)<sup>3</sup> proved to be good after some modifications. Males and females of the freshwater fish *Tilapia mossambica* were employed for the present study. Specimens about 12 cm. in length were found to be suitable. One set (Batch A) of specimens were injected with 0.1 and 0.2 ml. of 0.01% of colchicine in distilled water. The other batch (B) received 1 ml./50 gm. body-weight of 0.1% colchicine. The intra-muscular injections were given with a hypodermic syringe in the anterior half of the animal behind the head. The animals were sacrificed 2-3 hours after the injections. Specimens from Batch A were used for studying the karyotypes from gill epithelium, while the specimens from Batch B provided the material for a study of testis and ovary. The posterior gill arch was removed immediately after the specimen was sacrificed and dialysed in double distilled water for 10 to 15 minutes. It was then fixed in Newcomer's fluid for 15 minutes and stained in acetic orcein for an equal time. A gentle tapping of the gill arch in a drop of 45% acetic acid on a slide released the epithelial cells which were then squashed under a coverslip with slight pressure. After blotting off the excess liquid, the sides of the coverslip were sealed with gum-paraffin mixture. This technique yielded well-stained and well-spread preparations (Fig. 1).

The gonads were dissected out from specimens three hours after the injections and were minced with scissors in 0.9% solution of sodium citrate. Ten minutes later, the minced tissue was transferred to acetic orcein directly, stained for 25 minutes and squashed as before. Testis as well as ovary yielded many cells in division. A well-spread spermatogonial metaphase plate is shown in Fig. 2. The meiotic bivalents from the primary spermatocyte is shown in Fig. 3. Figure 4 is a oogonial metaphase plate from the ovary. One great advantage of

1. Bloch, R., *Am. J. Bot.*, 1946, **33**, 544.
2. Metcalfe, C. R. and Chalk, L., *Anatomy of the Dicotyledons*, London, 1950.
3. Gamble, J. S., *Flora of Madras*, Vol. I, Calcutta, 1957 (Rep. ed.).
4. Cooke, T., *Flora of Presidency of Bombay*, Vol. I, Calcutta, 1958 (Rep. ed.).
5. Hooker, J. D., *Flora of British India*, Vol. I, London, 1875.
6. Backer, C. A. and Bakhuizen van den Brink, R. C., Jr., *Flora of Java*, Netherlands, 1963, **1**, 183.
7. Jacobs, M., In *Flora Malesiana*, 1960, **6** (1), 105.

this technique, which yielded consistent results, is that both the male and female karyotypes from somatic as well as germ-cells could be critically analysed and compared. This has not been feasible so far.



FIGS. 1-4. Chromosomes of *T. mossambica* (Peters). Fig. 1. Mitotic metaphase from gill epithellum. Fig. 2. Spermatogonial metaphase. Fig. 3. Meiotic bivalents from testis. Fig. 4. Oogonial metaphase ( $\times$  ca, 3160).

The chromosome number of *T. mossambica* (Peters) as observed from both the male and the female cells is  $2n=44$  and  $n=22$ . The karyotype consists of 44 metacentric chromosomes, of which two are very large with sub-terminal centromeres while the rest are small with median centromeres. The sex chromosomes, if any, are not discernible.

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U.G.C. Centre for R. NATARAJAN.  
Advanced Study in K. SUBRAHMANYAM.  
Marine Biology,  
Marine Biological Station,  
Porto Novo, Madras State,  
November 11, 1967.

1. Ohno, S. *et al.*, *Cytogenetics*, 1965, 4, 117.
2. Roberts, F. L., *J. Morph.*, 1964, 115, 401.
3. Macphail, J. D., *J. Fish. Res. Board of Canada*, 1966, 23 (5), 767.
4. Roberts, F. L., *Progr. Fish-culturist*, 1967, 29 (2), 75.

## FORMATION OF ADVENTITIOUS ROOTS IN TOMATO SEEDLINGS BY CCC TREATMENT

DURING a course of investigation on the effect of certain growth retardants on the control of transpiration, it was observed that tomato seedlings treated with CCC [2-chloroethyl-trimethyl ammonium chloride] showed copious adventitious root formation.

When the root portion of the 24-day-old tomato (*Lycopersicon esculentum* Mill. variety—Marglobe) seedlings having the average height of 17.5 cm. and fresh weight 3.1 g. were kept immersed in CCC at  $10^{-4}$ M under conditions of diffused light, the formation of adventitious roots from the lower portion of the stem was evident within a week's time (Fig. 1).

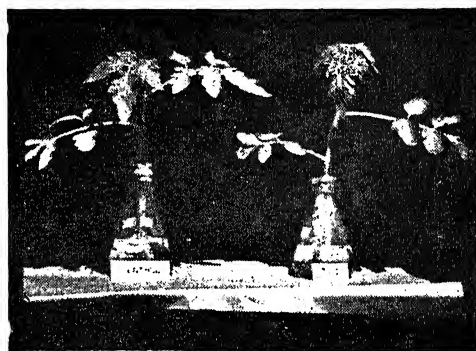


FIG. 1. The formation of adventitious roots in the CCC-treated tomato seedlings.

This observation supports the previous work of Libbert and Urban<sup>1</sup> who also noted an increase in the adventitious root formation in the CCC-treated cuttings of *Convolvulus sepium*. Lamba and Staba<sup>2</sup> observed only denser root hairs in *Digitalis lanata* due to CCC treatment in growth culture experiments. A recent report<sup>3</sup> has emphasized the inhibition of root formation in tomato cuttings by GA, whose mechanism of action is opposite<sup>4</sup> to that of CCC. The significance of the present observation is that prolonged CCC treatment at a lower concentration ( $10^{-4}$ M) can induce the formation of adventitious roots in young tomato seedlings.

Further work carried out in pot culture experiments also showed an increase in the dry weight of roots of the CCC-treated tomato plants. We thank Cyanamid India Limited, Bombay, for kindly supplying the sample of CCC.

Department of Botany,  
College of Agriculture,  
Bhubaneswar-3, Orissa,  
February 15, 1968.

D. MISHRA.  
G. C. PRADHAN.

1. Libbert, E. and Urban, J., *Naturwissenschaften*, 1964, **51**, 92.
2. Lamba, S. S. and Staba, E. J., *Phyton*, 1963, **20**, 175.
3. Jansen, H., *Planta (Berl.)*, 1967, **74**, 371.
4. Catney, H. M., *Ann. Rev. Plant Physiol.*, 1965, **15**, 271.

### INHERITANCE OF WAXY BLOOM IN EMMER WHEATS—REVERSAL OF DOMINANCE IN INTRA- AND INTER-SPECIFIC CROSSES

Waxy bloom on stem and leaves in wheat has long been recognised as one of the structural components leading to drought resistance and immunity against rust.<sup>1-3</sup> The presence of waxy coating also helps in avoiding the pathogens through its physiological or biochemical properties.<sup>4</sup>

segregations studied in these two crosses are summarized in Table I.

It will be seen from Table I that the  $X^2$  value in the first intra-specific cross is in agreement with the table values whereas in the second inter-specific cross it is not so. By adjusting the  $X^2$  value with a correction factor according to the procedure followed by Bailey<sup>9</sup> the  $X^2$  value in brackets shows agreement with the table values. These results have been later confirmed from  $F_3$  segregation.

These observations confirm the earlier reports on monogenic control for waxiness behaving as a recessive character (3 non-waxy : 1 waxy). However, the monogenic control for the same character in inter-specific cross shows a complete reversal of dominance so that  $F_2$  segregation for waxy : non-waxy presents itself as 3 : 1.

The author expresses his indebtedness to Dr. G. B. Deodikar, Director, for guidance. This work has been carried out under the I.C.A.R. wheat scheme.

TABLE I

Crosses		Non-waxy	Waxy	$X^2$	$\phi$ -value
1. <i>T. durum</i> -N-59 <i>T. durum</i> -Nurshit	Obs.	386	129	0.0006	0.95-0.98
	Exp. (3 : 1)	386.25	128.75		
2. <i>T. durum</i> -motiya <i>T. pyramidalis</i>	Obs.	129	304	5.3030 (5.0517)	0.001-0.01
	Exp. (1 : 3)	108.75	324.75		

Inheritance of this character has been studied so far only in inter-varietal crosses. Chavan *et al.*<sup>5</sup> have noted monogenic control of this character in *Triticum durum*. Likewise, Gandhi and Bhatnagar<sup>6</sup> and Rao *et al.*<sup>7</sup> working on varietal crosses of *T. durum* and *T. aestivum* detected a single pair of alleles responsible for this character. Matsumura<sup>8</sup> has found  $F_2$  segregation in a ratio of 13 wax-free : 3 waxy in a cross of *T. dicoccum*.

In the present analysis, inheritance of waxy coating on leaf-sheath has been studied in some intra- and inter-specific crosses among tetraploid wheats. *T. durum* female parents used in these crosses had waxy bloom on leaf sheath and male parents were wax free.  $F_1$  plants in first cross were non-waxy and in second cross were having waxy bloom.  $F_2$

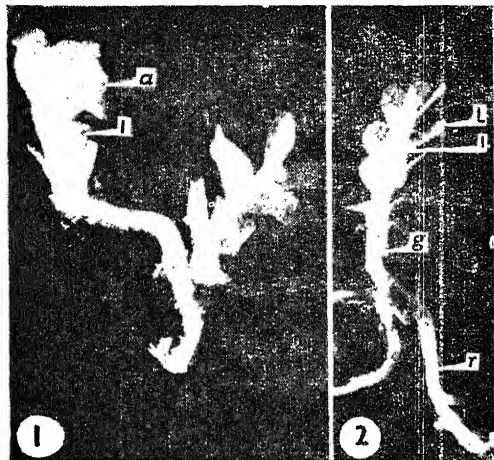
M.A.C.S. Laboratories,  
Poona-4, February 21, 1968.

V. P. PATIL.

1. Fruwirth, C., *Handbuch der landwirtschaftlichen Pflanzenzüchtung*, Ed. IV, Aufl. Berlin, 1923.
2. Cobb, N. A., *Agr. Gaz., N.S. Wales*, 1891, **2**, 493.
3. Vavilov, N. I., *The Origin, Variation, Immunity and Breeding of Cultivated Plants*, Chronica Botanica, 1949/50, p. 364.
4. Joshi, A. B., *Indian J. Genet.*, 1957, **17**, 305.
5. Chavan, V. M., Argikar, G. P., Hattigadi, P. S. and Solanki, M. S., *Curr. Sci.*, 1955, **24**, 314.
6. Gandhi, S. M. and Bhatnagar, M. P., *Indian J. Genet.*, 1962, **22**, 160.
7. Rao, M. V., Mathur, V. S., Ahire, N. G. and Narula, P. N., *Ibid.*, 1963, **23**, 19.
8. Matsumura, S., *Jap. J. Genet.*, 1949, **25**, 111.
9. Bailey, N. T. J., *Introduction to the Mathematical Theory of Genetic Linkage*, Clarendon Press, Oxford, 1961, p. 298.

**CALOBRYUM BLUMII NEES—A TAXON  
NEW TO INDIAN FLORA**

AN investigation of the liverworts collected from Jowai (Assam) has revealed the presence of *C. blumii*—the type species of the genus *Calobryum* Nees—earlier known to occur only in Java, Sumatra and New Guinea. The Jowai specimens of *C. blumii* are dioecious and yellowish-green. Their leafy gametophores are 10–20 mm. long. The male plants (Fig. 1) are larger and more robust than the female plants (Fig. 2). At the apex of the male gametophores, numerous stalked antheridia are borne and remain confined within the antheridial cupule (Fig. 1, *a*) formed by imbricately aestivated apical leaves. The female gametophores are acrogynous. The archegonia remain confined inside the chamber of a dome formed by the three apical youngest leaves. Sporophytes were not present in these specimens.



FIGS. 1–2. *Calobryum blumii* Nees. Fig. 1. A male plant. *a*, antheridial cupule; *l*, small leaf,  $\times 5.5$ . Fig. 2. A female plant. *L*, large leaf; *l*, small leaf; *g*, gametophore; *r*, rhizome,  $\times 5.5$ .

The leaves in both male and female gametophores are simple, rotundate to broadly orbicular and radially arranged in a tristichous spiral phyllotaxy. In dorsal row the leaves are always smaller than those of the latero-ventral rows. The resultant anisophylly leads to the apparent dorsiventrality of the gametophores. It is more evident in the female plants (Fig. 2). Leaves of the female gametophores are also less spreading than those of the male gametophores. Of the numerous specimens examined, none had apically-branched gametophores; however, in few cases, axillary branches were present.

Many contemporary taxonomists dealing with the liverworts consider *Calobryum* as congeneric with *Haplomitrium* Nees. However, recently Udar and V. Chandra<sup>2</sup> have drawn attention towards the desirability of reassessment of this notion. A study of the Indian representatives of Calobryales has afforded evidences in favour of the original concept that both the genera, viz., *Haplomitrium* and *Calobryum* are taxonomically distinct.

The present record of *C. blumii* further adds significance to the interesting distribution of Calobryales in India.<sup>1,2</sup> In comparison to the general distributional pattern of Calobryales on the globe, it is only the east Himalayan territory where three taxa of this order, viz., *H. hookeri*, *C. blumii* and *C. indicum* Udar et S. Chandra<sup>3</sup> are distributed.

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University of Lucknow,

Lucknow, January 30, 1968.

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1. Udar, R. and Chandra, S., *Curr. Sci.*, 1961, **30**, 22.  
2. — and Chandra, V., *Ibid.*, 1965, **34**, 618.  
3. — and Chandra, S., *Rev. Bryol. et Lichenol.*, 1965, **33**, 555.

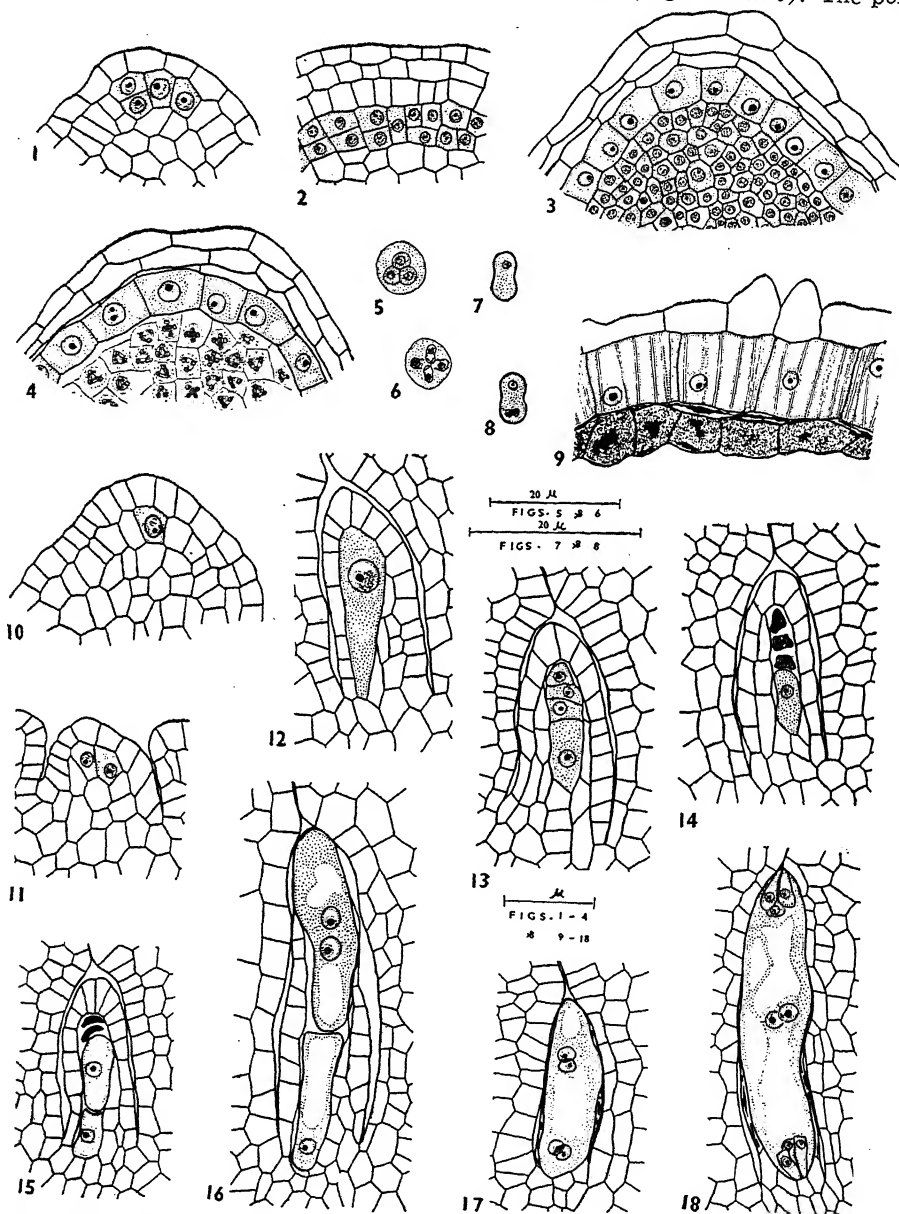
**A NOTE ON THE SPOROGENESIS AND  
GAMETOGENESIS IN ADELOCARYUM**

THE genus *Adelocaryum* belongs to the tribe Cynoglossæ of the family Boraginaceæ. It includes two species, viz., *A. malabaricum* and *A. caelestinum*.<sup>1</sup> The present note deals with the sporogenesis, and the development of gametophytes in *Adelocaryum caelestinum* (Lindl) Brand.

The anther primordium becomes four-lobed. A plate of 3–4 hypodermal archesporial cells is recognizable in the homogeneous mass of cells in each lobe. They are densely cytoplasmic and show conspicuous nuclei (Fig. 1). The archesporial initials divide periclinally to form an outer layer of primary parietal cells and an inner layer of primary sporogenous cells (Fig. 1). The parietal cells further divide both periclinally and anticlinally to form three layers of cells. Thus the anther wall is composed of four layers of cells; the innermost of these constitutes the tapetum (Figs. 2 and 3). The tapetal cells remain uninucleate throughout (Fig. 4). The tapetum is finally consumed. The hypodermal layer in the anther wall develops into the endothecium; the cells of this layer elongate tangentially and develop fibrillar thickenings (Fig. 9). The cells of the middle layer degenerate.

The primary sporogenous cells divide in all directions and form a rounded mass of microsporocytes (Fig. 3). The microsporocytes under-

go simultaneous meiotic divisions (Fig. 4) and form both tetrahedral and decussate microspore tetrads (Figs. 5 and 6). The pollen-grains



FIGS. 1-18. Sporogenesis and the development of gametophytes in *Adolocaryum celestinum* (Lindl) Brand. Figs. 1-9. Microsporogenesis and the development of the male gametophyte: Fig. 1. T.s. anther lobe showing two archesporial cells, a primary parietal cell and a primary sporogenous cell. Fig. 2. L.s. anther lobe showing two layers of sporogenous cells and two layers of parietal cells. Fig. 3. T.s. anther lobe showing the microsporocytes, tapetal cells and the wall layers. Fig. 4. T.s. anther lobe showing the microsporocytes under meiosis II. Fig. 5. Tetrahedral microspore tetrad. Fig. 6. Decussate microspore tetrad. Fig. 7. Uninucleate pollen-grain. Fig. 8. Three-celled pollen-grain. Fig. 9. Portion of anther wall showing the fibrillar endothecium and the degenerating tapetum. Figs. 10-18. Megasporogenesis and the development of the female gametophyte: Fig. 10. Single-celled archesporium. Fig. 11. Two-celled spore. Fig. 12. Megaspore. Fig. 13. Linear megaspore tetrad. Fig. 14. Functional megaspore. Fig. 15. Portion of the ovule showing the third and the fourth megaspores of the tetrad enlarged and the two degenerating megaspores. Fig. 16. Portion of the ovule showing the two-nucleate stages of the embryo-sac. Fig. 17. Four-nucleate embryo-sac. Fig. 18. Eight-nucleate embryo-sac.



are slightly elongated and possess a median constriction which gives them the shape of a dumbbell (Fig. 7). The two germ pores are situated at the region of constriction. The pollen grains measure 7-8 microns by 3-4 microns. They are shed at three-celled stage (Fig. 8). Dehiscence of the anther occurs at the junction of the pollen sacs. The endothelial cells at this region lack fibrillar thickenings, and the epidermal cells are smaller in size.

The ovary is superior, bicarpellary, bilocular and syncarpous. It becomes four-loculed at later stages due to the development of a false septum. The ovules are anatropous, but due to the presence of a gynobase they are deeply seated in the locules. They are unitegminial and tenuinucellar. The funiculus is long and the ovules are bent in such a way that the micropyle of all the four ovules is directed towards the placenta. A single vascular strand enters the funiculus and branches in the integument; the branches run close to the epidermis of the integument.

In the ovule, the archesporium is usually single-celled (Fig. 10), but a multiple archesporium consisting of two to four cells is also seen occasionally (Fig. 11). However, only one cell functions further and the others degenerate. The functional archesporial cell enlarges and directly becomes the megasporocyte (Fig. 12) which undergoes meiosis and forms a linear tetrad of megaspores (Fig. 13). Usually the chalazal megaspore develops into an embryo-sac (Fig. 14) but occasionally the second or the third megaspore in the tetrad may function further, in addition to the chalazal megaspore (Figs. 15 and 16) which alone finally develops into an eight-nucleate embryo-sac of *Polygonum* type<sup>2</sup> and the others degenerate (Figs. 17 and 18). The nucellar epidermis degenerates as the functional megaspore enlarges.

A mature embryo-sac is longitudinally stretched. The egg apparatus consists of a pair of synergids which overlap the egg. The antipodals are organized as regular cells. They degenerate before fertilization. The two polar nuclei fuse to form a secondary nucleus only after fertilization.

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Central College, TASNEEM FATHIMA.  
Bangalore, February 16, 1968.

# DETECTION OF INDOLE-3-ACETIC ACID (IAA) IN SWEET POTATO (*IPOMOEA BATATAS* LAM.)

THE presence of auxin in plant parts has been reported in several annuals and a few fruit plants. Koshimizu and Nishida<sup>1</sup> suggested that growth hormone, synthesised in the sweet potato stem was responsible for root enlargement. Ito and Kato<sup>2</sup> reported that root enlargement of sweet potato was favoured by the supplement of carbohydrate and synthetic growth substances. They reported that the growth hormone concerned in the root enlargement was IAA, which came from the leaves. The occurrence of indole-3-acetic acid (IAA) in the shoot tips of sweet potato is reported in this note.

The growing stem tips were frozen at 0° C. for 24 hr. and extracted with cold peroxide-free ethyl ether. The extract was distilled, the residue was digested followed by separation of chlorophyll. The ether extract was mixed with 5% sodium bicarbonate. The bicarbonate fraction was separated, acidified to pH<sup>3</sup> and re-extracted with ether. The extract was concentrated to 0.5 ml. at 70° C. The concentrated residue was dissolved in small quantities of absolute alcohol and spotted on Whatman No. 1 filter-paper. The chromatogram was ascendingly run in butanol-ammonia-water (100-100-8), for 14 hr. following the procedure of Wright.<sup>3</sup> The paper was air-dried, and sprayed with modified Salkowski reagent [HCl O<sub>4</sub> (5%) 50 parts + 0.05 M. FeCl<sub>3</sub> 1 part] to locate the auxin. By co-chromatography and matching R<sub>f</sub> and colour reaction the auxin was identified as IAA. The results indicate the possible synthesis of IAA in the shoot which might be concerned in the enlargement of sweet potato root.

The author is thankful to Dr. G. Rangaswami, Dean, University of Agricultural Sciences, Bangalore 24, and formerly Dean, Faculty of Agriculture, Annamalai University, under whose guidance the work reported here was carried out.

Faculty of Agriculture, RM. ALAGAPPAN.  
Annamalai University,  
Annamalainagar,  
Madras State, March 4, 1968.

1. Gamble, J. S., *Flora of the Presidency of Madras*, 1921, 2, 622.
2. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, Delhi, 1960.

1. Koshimizu, J. and Nishida, M., *Bot. Mag. Tokyo, Abs.*, 1949, 62, 146.
2. Ito, H. and Kato, T., *Tohoku J. Agric.*, 1950, 10, 33.
3. Wright, S. T. C., *J. Hort. Sci.*, 1956, 31, 196.

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## REVIEWS AND NOTICES OF BOOKS

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**Recent Advances in Biological Psychiatry** (Vol. VIII). Edited by Joseph Wortis. (Plenum Press, New York), 1965. Pp. xiii + 367. Price \$12.50.

This volume represents the Proceedings of the Twentieth Annual Convention and Scientific Program of the Society of Biological Psychiatry, New York City, April 30 to May 2, 1965.

The subject-matter in this volume has been dealt with in six parts as listed below: Part I. Clinical Models and Formulations; Part II. The Laboratory Animal as Model; Part III. Model Psychopathologic States; Cholinergic Mechanisms in Mental Illness: Anticholinergic Hallucinogens—A Panel Discussion; Part IV. Animals and Molecules; Part V. The Neurophysiologic Model; and Part VI. Computer Analysis and Models with Special Reference to EEG. C. V. R.

**Late Eighteenth Century European Scientists.** Edited by R. C. Olby. (Pergamon Press), 1966. Pp. 209. Price 18 sh. 6d.

The aim of this book is to give an account of the progress which was made by European scientists at the close of the eighteenth century in the subjects of chemistry, electricity, astronomy and botany.

The contents of this book are: Introduction, by R. C. Olby; Jean Lamarck, 1744-1829, by K. M. Jack; Joseph Koelreuter, 1733-1806, by R. C. Olby; Antoine Lavoisier, 1743-1794, by D. J. Knight; Henry Cavendish, 1731-1810, by D. C. Goodman; Alessandro Volta, 1745-1827, by C. G. Vosa; James Watt, 1736-1819, by J. D. North; and William Herschel, 1738-1822, by R. C. Olby. C. V. R.

**Annual Review of Phytopathology** (Vol. 5). Edited by J. G. Horsfall. (Annual Reviews, Inc., 4139 El Camino Way, Palo Alto, California 94306, U.S.A.), 1967. Pp. vii + 470.

Six years ago the newly appointed Editorial Committee of the Annual Review of Phytopathology met with J. Murray Luck, Editor-in-Chief, at the Offices of Annual Reviews, Inc., to plan this new journal, number twelve in the series.

A total of 89 reviews have been published in the first five volumes, on the wide range of subjects shown on pages 468-470 of this volume. Authors from 15 foreign countries have prepared 38 (about 43%) of the reviews.

The principal titles of the subjects dealt with in this volume are: Prefatory Chapter by A. E. Muskett; Appraisal of Disease; Pathogens; Morphology and Anatomy; Physiology of Host-Pathogen Interaction; Epidemiology; Influence of Environment; Action of Toxicants; Chemical Control; Breeding for Resistance; Special Topics: Phytopathology in a Hungry World and Functions and Maintenance of a Type-Culture Collection. C. V. R.

**Communication in Science: Documentation and Automation.** (A Ciba Foundation Volume). Edited by Anthony De Reuck and Julie Knight. (J. and A. Churchill Ltd., 104, Gloucester Place, London W. 1), 1967. Pp. xi + 274. Price 60 sh.

The Ciba Foundation was opened in 1949 to promote international co-operation in medical and chemical research among scientists from all parts of the world. Its house at 41 Portland Place, London, has become a meeting place well-known to workers in many fields of science. Every year the Foundation organizes from six to ten three-day symposia and three or four one-day study groups, all of which are published in book form.

This volume contains the following papers and followed by discussion in each case: Chairman's Introduction, by Sir Ewart Jones; Introduction: the problem stated; Communication in a science: the system and its modification; The user-system interface today: national and international information systems; Planning the consequences of unplanned action in scientific communications; The Mechanization of documentation—a tentative balance sheet; The efficiency of index languages; The Biomedical Communications Problem; Information Services in Physics; Planning and Development of the European Space Documentation Service: an Example of International Collaboration; The Chemical Compound Registry System; Some Problems in Developing National Systems for Science Information; Scientific Information Services in

Sweden; Scientific Information Services in the Soviet Union; Communication in Science: the ends—philosophy and forecast; The New Forms and Uses of Information Systems; Potentialities of a Multi-Media, Inter-University Educational Network. C. V. R.

Continuum Mechanics (Vol. I). *Mechanical Foundations of Elasticity and Fluid Dynamics*. By C. Truesdell. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York, N.Y. 10011), 1966. Pp. xvi + 218. Price \$ 7.50.

This volume of reprints is one of the four designed to reflect the resurgence of continuum mechanics in the past few years. Nothing published earlier than 1945 is included, and nothing later than 1961. The contents of the four volumes are connected, sometimes loosely and sometimes closely, with each other, so that the division is somewhat arbitrary.

Volume I contains the following chapters: 1. Preliminary Discourse; 2. Isotropic Functions; 3. General Theory of Continuous Bodies; 4. Elasticity; 5. Fluid Dynamics; 6. Superposition Theories; and 7. Progress and Program of the General Theories. C. V. R.

Visual Illusions—Their Causes, Characteristics and Applications. By Luckiesh—with a New Introduction, by William H. Ittelson. (Dover Publications, Inc., New York), 1965. Pp. xxi + 252. Price \$ 1.50.

This Dover edition, first published in 1965, is an unabridged and unaltered republication of the work originally published by D. Van Nostrand Company and Constable and Company, Ltd., in 1922. This edition also contains a new Introduction by William H. Ittelson.

Visual illusions are all around us. For example, the figures "S" and "8": top and bottom loops appear to be approximately even. However, invert the figures 888SSSS, and the evenness is shown to be an illusion. This book is a layman's introduction to visual illusions, arranging virtually all the types known in categories with one or two examples to illustrate each.

After two short chapters describing the mechanism of the eye and general principles of vision, the author describes visual illusions in their many types. Geometrical figures form a large section, with many drawings of illusions and instructions for simple experiments. The figures are classed as illusions of

interrupted extent, of contour and of contrast; and illusions created by angles and equivocal figures. Another section deals with illusions involving color. After-images, chromatic aberration, depth and distance illusions, and contrasts of brightness and colour are some of these. Common sights that occur every day in nature are discussed and found to be illusions. Final chapters in the book suggest practical applications for illusions in the fields of painting; architecture, interior decoration, lighting, magic and camouflage. C. V. R.

Chemical Study of Some Indian Archaeological Antiquities (Uttar Pradesh State Council of Scientific and Industrial Research Monograph Number Ten). By Satya Prakash and N. S. Rawat. (Asia Publishing House, Bombay-1), 1965. Pp. 85. Price Rs. 6.00.

This monograph gives a critical account of the chemical analyses of ancient Indian mortars, plasters, pigments, glazes, pottery, glass, coppers, bronzes and coins and is of value to chemists and archaeologists alike. It, in addition, gives the results of analyses carried in the author's laboratories, especially on Kausambi antiquities and coins of certain period. C. V. R.

Gallium Arsenide. Edited by Dr. A. C. Stickland. Assisted by Miss M. E. Hilton. (Institute of Physics and the Physical Society, 47 Belgrave Square, London, S.W. 1), 1967. Conference Series No. 3. Pp. vii + 246. Price U.S. \$ 12.00.

This volume contains 35 papers presented at the International Symposium organized by The Institute of Physics and The Physical Society in co-operation with The Avionics Laboratory of the U.S. Air Force held at Reading University from 26th-28th September 1966. The subjects covered included materials preparation, optical effects, microwave devices and junction devices. Also included are the discussions, two periods of which were allotted to each session. C. V. R.

Physical Basis of Yield and Fracture (Conference Series 1)—1966 Conference Proceedings. Edited by Dr. A. C. Stickland, Assisted by Miss R. A. Cook. (Institute of Physics and the Physical Society), 1967. Pp. vii + 303. Price £ 4.10'sh.

This book contains 38 papers presented at the Conference on the Physical Basis of Yield

and Fracture organized by the Stress Analysis Group of The Institute of Physics and The Physical Society and held at Oxford University, in September 1966. The subjects covered included Theory, Metals, Polymers and Miscellaneous Materials followed by discussions on each subject. C. V. R.

Gas Effluent Analysis. Edited by William Lodding. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1967. Pp. 220. Price \$10.75.

Many chemical reactions and decompositions are accompanied by evolution or exchange of gases. A great deal of useful information can be obtained if gases evolving, while thermal analysis is in progress, are carefully monitored and analysed. An important application of gas effluent analysis is to follow the progress of decomposition or reaction by measuring the rate of gas evolution under controlled conditions. Gas effluent analysis, like many other techniques, is evolving rapidly, and the object of the present monograph is to describe and evaluate the GEA technique.

Seven authors have contributed to the seven chapters in this volume. Four chapters are concerned with the various methods of gas detection, separation, and quantitative analysis in a flowing stream. There are chapters devoted to the techniques and apparatus of pyrolysis and thermoparticulate analysis. The possibilities as well as the limitations of GEA technique are discussed in detail by experts working in this field, and this compact monograph is a definitive and timely addition to the literature on the subject. A. S. G.

Human Follicle-Stimulating Hormone. By Paul Roos. (Almqvist and Wiksells Boktryckeri AB, Uppsala), 1968. Pp. 93.

This monograph is the inaugural dissertation by the author for the degree of Doctor of Philosophy of the Uppsala University. It deals with the pituitary hormone FSH (a glycoprotein), its isolation, chemical, physical, immunological and biological properties.

A. S. G.

Direct Correlation of Physical Constants Through Transcendental Equations. By F. Crook, Grange Place, Guernsey, C.I. British Isles.

The author's thesis in this self-published tract is "If we bring together those aspects of nature which would seem to be closely related, were it not for theories that keep them apart, many exact correlations will emerge". As the title indicates, he attempts in this 16-page pamphlet at showing that the physical constants are the natural solutions of transcendental equations. A. S. G.

Dimensional Analysis and Hydraulic Model Testing. By H. M. Raghunath. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), Pp. 112. Price Rs. 15-00.

Essentially written for the undergraduate students of engineering, this little monograph is intended to cover their course on the subject of the title. It includes problems and worked-out examples. A. S. G.

#### Books Received

Gas Effluent Analysis. By W. Lodding. (Marcel Dekker Inc., 95, Madison Avenue, New York, N.Y.), 1967. Pp. xi + 220. Price \$10.75.

Harvesting the Sun—Photosynthesis in Plant Life. Edited by A. S. Pietro, F. A. Greer, T. J. Army. (Academic Press, Inc., New York), 1967. Pp. ix + 341. Price \$7.50.

The Teaching of Ecology—British Ecological Society Symposium No. 7. Edited by J. M. Lambert. (Blackwell Scientific Publications, 5, Alfred Street, Oxford, England), 1967. Pp. xi + 121. Price 47 sh. 6d.

Annual Review of Nuclear Science. Edited by Emilio Segre. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, Calif., U.S.A.), 1967. Pp. v + 546. Price: U.S.A. \$8.50; Elsewhere \$9.00.

Dimensional Analysis and Hydraulic Model Testing. By H. M. Raghunath. (Asia Publishing House, Calicut St., Bombay-1), 1967. Pp. 112. Price Rs. 15-00.

# THE INFLUENCE OF BEE VENOM ON THE OSMOTIC FRAGILITY OF YOUNG RABBIT RBC

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THE resistance of erythrocytes to hemolysis is clinically measured by various classical tests,<sup>1</sup> and recently by a new method using the fragiligraph.<sup>2-5</sup> By this method the influences of bee venom on the osmotic fragility of human RBC were studied.<sup>5</sup> The venom was found to increase the osmotic fragility and induced the division of the RBC into two populations of different osmotic fragility patterns. The fragiligrams were very typical, suggesting an auxiliary test to prove venom activity in blood.

In this study, the influence of bee venom on the osmotic fragility of young rabbit red-blood cells, which are normally dividing into two populations, was established.

Twelve rabbits, 1-3 months of age, were studied. Blood samples were taken from the central vein of the ear by vein puncture and collected in heparinized capillary tubes of a type used for microhematocrit.

Normal fragiligrams were obtained by a method based on gradual hemolysis in hypotonic NaCl solutions.<sup>2-5</sup>

The influence of the venom was studied by mixing 1 ml. of buffered isotonic NaCl solution containing 20 gamma per ml. of bee venom with different volumes, ranging from 1 to 999 ml. of 1:10 RBC suspension in buffered isotonic NaCl solution (Concentrations 1:1-1:1000 in the tables). After 20-30 seconds, 0.075 ml. of the suspension was introduced into a container cell for recording, by the same method used for normal fragiligrams (Test 1 and time interval 1 in the tables). A few minutes later, a second and sometimes a third record from the same sample was made (Tests 2 and 3 time intervals 2 and 3 in the tables).

The relative values of the RBC populations were obtained by a direct planimetry of the area under the derivative curves.

In the fragiligram (Cumulative curves in Fig. 1), the degree of hemolysis (Ordinate-%) recorded as a function of time during which the venom was present in the RBC suspensions, and the hemolysis took place (Abscissa—minutes). The time values were transferred to concentration values of NaCl solutions.

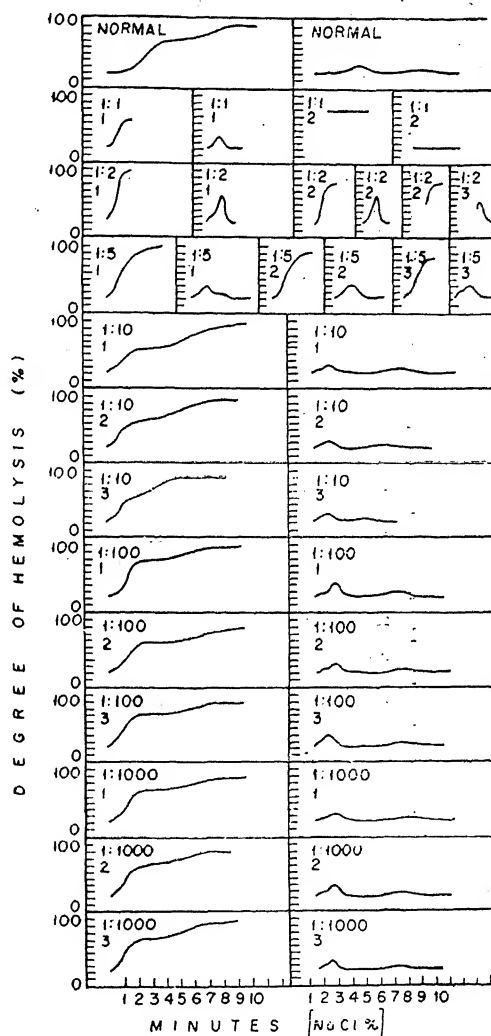


FIG. 1. The fragiligrams and their derivatives obtained from the controls and the treatment studies from rabbits one to three months of age.


The fragiligrams, the derivative curves and the fragility values for rabbit in normal conditions and in the presence of the bee venom with indications to the important point on the curves, are presented in Fig. 1 and Table I. The relative values of the RBC population are presented in Table II.

TABLE I

*Osmotic fragility of erythrocytes from the controls and the treatment studies from rabbits 1-3 months of age*

Concentration	Test No.	Time interval minutes	Minimum resistance I		Maximum resistance Ia		Maximum resistance Ib		Maximum resistance Ic		Minimum resistance II		Maximum resistance I	
			Time (minutes)	NaCl (%)	Time (minutes)	NaCl (%)	Time (minutes)	NaCl (%)	Time (minutes)	NaCl (%)	Time (minutes)	NaCl (%)	Time (minutes)	NaCl (%)
Controls	1	0.50 ±0.03	2.1 ±0.05	0.52	..	..	..	..	4.6 ±0.23	0.32	6.7 ±0.47	0.24	11.0 ±2.01	0.18
1:1	1	0.20 ±0.01	0.3 ±0.01	0.80	..	..	..	..	1.4 ±0.10	0.59	..	..	..	..
	2	10.25 ±0.60	0.0 ±0.00	0.90	..	..	..	..	..	..	..	..	..	..
1:2	1	0.50 ±0.02	0.0 ±0.00	0.90	0.5 ±0.03	0.78	..	..	1.3 ±0.09	0.61	..	..	..	..
	2	6.30 ±0.10	0.0 ±0.00	0.90	0.5 ±0.05	0.78	..	..	1.3 ±0.08	0.61	..	..	..	..
	3	12.20 ±1.01	0.0 ±0.00	0.90	..	..	..	..	0.9 ±0.13	0.68	..	..	..	..
1:5	1	0.50 ±0.03	0.2 ±0.03	0.86	0.7 ±0.02	0.74	1.5 ±0.30	0.58	2.5 ±0.23	0.46	..	..	..	..
	2	9.50 ±0.95	0.2 ±0.04	0.86	0.5 ±0.03	0.78	1.9 ±0.28	0.52	2.3 ±0.20	0.48	..	..	..	..
	3	17.70 ±2.80	0.2 ±0.01	0.86	0.7 ±0.01	0.74	..	..	2.3 ±0.21	0.48	..	..	..	..
1:10	1	0.50 ±0.11	0.4 ±0.05	0.70	0.9 ±0.02	0.68	..	..	2.4 ±0.18	0.47	4.4 ±0.31	0.33	8.7 ±0.41	0.20
	2	16.50 ±0.93	0.2 ±0.03	0.86	0.7 ±0.06	0.74	..	..	1.9 ±0.10	0.52	3.2 ±0.27	0.40	7.1 ±0.25	0.23
	3	37.00 ±3.45	0.2 ±0.02	0.86	0.7 ±0.10	0.74	..	..	2.0 ±0.31	0.53	2.8 ±0.29	0.42	5.1 ±0.13	0.29
1:100	1	30 ±0.05	0.3 ±0.02	0.82	0.9 ±0.20	0.68	..	..	2.5 ±0.20	0.46	5.2 ±0.40	0.29	8.6 ±0.29	0.21
	2	10.70 ±1.09	0.3 ±0.02	0.82	1.0 ±0.32	0.67	..	..	2.5 ±0.15	0.46	5.8 ±0.21	0.27	8.6 ±0.12	0.21
	3	23.90 ±2.92	0.2 ±0.01	0.86	0.5 ±0.10	0.21	..	..	2.0 ±0.13	0.53	5.5 ±0.38	0.28	8.0 ±0.20	0.22
1:1000	1	0.30 ±0.02	0.2 ±0.01	0.86	0.8 ±0.21	0.69	..	..	2.5 ±0.15	0.46	5.2 ±0.33	0.29	8.0 ±0.25	0.22
	2	12.50 ±2.35	0.2 ±0.01	0.86	0.8 ±0.17	0.69	..	..	2.5 ±0.20	0.46	4.8 ±0.18	0.30	7.8 ±0.40	0.23
	3	23.00 ±5.31	0.2 ±0.04	0.86	0.6 ±0.10	0.76	..	..	2.4 ±0.30	0.47	4.4 ±0.25	0.32	7.4 ±0.31	0.23

Referent point  
on the deri-  
vative curve



The normal fragiligrams and the normal derivatives are bimodal as typical for normal young rabbit RBC populations.<sup>6</sup> The fragility values are within the normal range.

An increased fragility of the RBC populations, fusion of the two populations into one, the appearance of a third population and changes in the relative values of the populations are found according to the influence

of the different venom concentrations and tests. The fragility of the RBC is increased and the fusion of the populations is more prominent, moving from the lowest to the highest venom concentration and from the first to the third test.

The osmotic fragility of rabbit RBC has recently been studied.<sup>6,7</sup> According to the authors, the fragiligrams of young rabbit

TABLE II  
The relative values of the RBC populations obtained from rabbit 1-3 months of age

Concentration	Test No.	Time interval minutes	Population I (%)			Population II (%)
			I <sub>a</sub>	I <sub>b</sub>	I <sub>c</sub>	
Controls	1	0.50±0.03	..	52.6±8.3	..	47.3±5.1
1:2	1	0.50±0.02	13.9±2.8	86.1±6.6	..	..
	2	6.30±0.10	21.9±5.1	78.0±5.7	..	..
1:5	1	0.50±0.03	12.9±1.9	61.2±4.7	25.8±2.5	..
	2	9.50±0.95	9.4±1.7	84.3±5.9	6.2±1.0	..
	3	17.70±2.30	17.8±3.1	82.2±7.1	..	..
1:10	1	0.50±0.11	13.5±2.5	43.2±9.3	..	42.2±3.3
	2	9.50±0.93	18.5±4.0	40.7±9.5	..	40.7±4.7
	3	37.00±3.79	12.5±2.0	50.0±9.9	..	37.5±4.1
1:100	1	0.30±0.05	9.3±1.6	65.1±6.3	..	25.5±6.2
	2	0.70±1.09	11.1±2.9	57.8±6.9	..	31.1±3.4
	3	23.90±2.92	15.6±3.5	51.3±1.3	..	25.1±2.2
1:1000	1	0.30±0.02	16.7±2.4	56.2±7.7	..	23.3±2.5
	2	12.50±2.35	12.5±1.3	62.5±5.4	..	25.0±4.3
	3	23.00±5.31	12.5±2.3	53.1±2.7	..	34.3±3.1



are bimodal, indicating two erythrocyte populations; the "Adult" and "Fœtal" types. Similar results were obtained in the controls of this study.

The relative values of "Young" (64.1% ± 7.3) and "Old" (36.5% ± 7.3) rabbit RBC were previously obtained by the electronmicroscope.<sup>8</sup> The same values were measured in the fragiligrams of normal young rabbits (Controls of Table II). It may be, that the electronmicroscope differentiates between "Adult" and "Fœtal" RBC and not between "Young" and "Old" RBC. The differentiation between "Young" and "Old" erythrocytes which are both components of "Adult" RBC type, might be achieved by the fragility test in the presence of bee venom or its active factors, since they induce the division of the "more fragile population" (Population 1 in Table II) which was proved to be identical with the "Adult" RBC,<sup>6</sup> into two populations.

The division of human RBC, by the osmotic fragility into two populations, has been studied in various conditions,<sup>9-11</sup> including the influence of bee venom.<sup>5</sup> The fragiligrams were bimodal, indicating two RBC populations, both of increased fragility or one of them of an increased fragility and the other of a decreased fragility. The results of the treatment in this experiment were compatible with

those found by the influence of the bee venom on human RBC. The osmotic fragility was increased and the normal "more fragile population" (The "Adult" RBC) was divided into two populations (Concentrations 1:10-1:1,000).

Similar to the findings for human RBC, the fragiligrams of rabbit RBC in the presence of bee venom were typical and reproducible. In addition, the fragiligrams obtained were found to be a function of both the venom concentration and the time during which the venom was present in the RBC suspensions (Tests 1, 2 and 3).

1. Dacie, J. V. and Lewis, S. M., *Practical Hematology*, J. & A. Churchill, London, 1963.
2. Danon, D., Nevo, A. and Marikovsky, Y., "Preparation of erythrocyte ghosts by gradual hemolysis in hypotonic aqueous solution," *Res. Coun. Israel Bull.*, 1956, 6 E, 36.
3. —, "A rapid micro method for recording red cell osmotic fragility by continuous decrease of salt concentration," *J. Clin. Path.*, 1963, 16, 377.
4. —, Frei, E. H., Frei, Y. F. and Lipkin, Y., "An instrument for automatically recording the osmotic fragility curve of red-blood cells and/or its derivative," *Trans. IEEE on Bio. Medical Electronics*, BME, 1963, 10, 1, 24.
5. Hort, I. and Herz, A., "The influence of bee venom on the osmotic fragility of human RBC," *Experientia*, 1967 (in press).

6. Perk, K., Frei, Y. F. and Herz, A., "Osmotic fragility of red-blood cells of young and mature domestic and laboratory animals," *Am. J. Vet. Res.*, 1964, **25**, 1241.
7. Frei, Y. F. and Perk, K., "Osmotic fragility of rabbit embryo RBC," *J. Cell. and Comp. Physiol.*, 1964, **64**, 97.
8. Danon, D. and Perk, K., "Age population distribution of erythrocytes in domestic animals—An electron microscopic study," *Ibid.*, 1962, **59**, 117.
9. Prankard, T. A. J., *The Red Cell*, Blackwell, Oxford, 1961.
10. Danon, D., Frei, Y. F., Rimón, A. and Ben-David, A., *Osmotic Fragility as a Routine Test in a Blood Bank. Transfusion*, 1964, **4**, 339.
11. Rapoport, S., "Osmotic and chemical changes of erythrocytes in stored blood. I. Blood preserved in sodium citrate, neutral and acid citrate-glucose mixture," *J. Clin. Invest.*, 1947, **26**, 591.

## ORIENTED ADSORPTION OF ALIPHATIC NORMAL ALCOHOLS IN THE MONOLAYER ON FIBROUS SILICA GEL

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THE subject of adsorption is one of the oldest and yet it has remained new in view of the voluminous amount of researches which are being published. The adsorbent and adsorbate materials used by different workers are numerous and varied in composition and the adsorption isotherms obtained have large variety of shapes. The BET classification<sup>1</sup> of the different isotherms into 5 typical categories has been a distinct advance and simplification. On the theoretical interpretation of adsorption, at the time when Langmuir looked upon adsorption as purely monomolecular and Zsigmondy, McGavack and Patrick as purely capillary condensation, neither of them being completely successful in explaining all the diverse facts of adsorption, the multimolecular adsorption theory proposed by Brunauer, Emmett and Teller has been a further advance in the subject. The sorption-desorption hysteresis has still remained a vexed and unsolved problem.

Monsanto Company, U.S.A., has produced a new form of silica aerogel of trade name Santocel C. This is a fine loose dusty powder, white in colour. Its air volume is 94%.<sup>2</sup> The particles are composed of submicroscopic fibres of 25 to 35 Å diameter and approximately 330 Å apart with a specific surface of 600 sq. m. per gm. This product is essentially meant for use as a flattening agent in protective and decorative coatings.<sup>3</sup> It has been used by Puddington<sup>4</sup> in making stopcock lubricant in glycerine for organic vapours. This new form of silica-fibrous silica gel (Santocel C) has been used as the adsorbent and methyl, ethyl, *n*-propyl, *n*-butyl and *n*-amyl alcohols as

adsorbates in the present study of the nature of adsorption in the monolayer and sorption-desorption hysteresis.

Quartz fibre spring technique<sup>5</sup> has been employed in the present investigations. Fibrous silica gel was heated to 250°C. for 2 hrs. in order to remove any organic vapour and the activated gel was used in studying a series of sorptions and desorptions of the aliphatic alcohols at 35°C. The study was continued upto 3rd or 4th cycle. In each system there has been permanent and reproducible hysteresis loop and the loops have been presented in Fig. 1 in which the volume of alcohol adsorbed per 100 gm. of gel is plotted against the relative vapour pressure of the alcohol.

The isotherms of all the five alcohols have clearly defined "Knees". According to BET theory, the "Knee" signifies the transition from monomolecular to multimolecular adsorption. By the application of BET equation to the isotherms, the monolayer capacity for each alcohol is determined. From the monolayer capacity and knowing the cross-section area of the alcohol molecule, the specific surface of the fibrous silica gel has been calculated. There are three possible values for the cross-section depending upon the shape of the molecule and mode of adsorption. The molecule may be assumed to be spherical and the diameter *D* spherical<sup>6</sup> and the cross-section are obtained from molecular weight and density. The alcohol molecule being linear, there are two modes of oriented adsorption perpendicular and parallel to surface. The cross-section of the linear molecule is (4.55)<sup>2</sup> Å<sup>2</sup>. Knowing



the total volume of the molecule  $D^3$  spherical, the length of the molecule and also the area along the length of the molecule are calculated. The values of the three different cross-sections are shown in Table I. The values of the specific surface calculated for these 3 cross-sections are also shown.

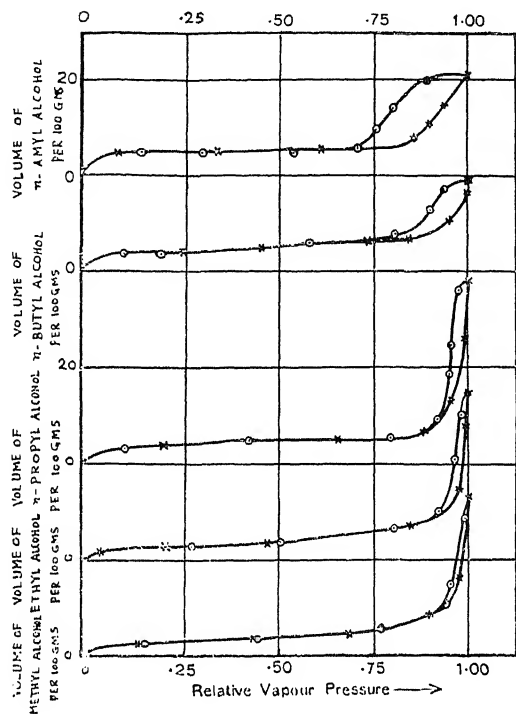


FIG. 1. Sorption and desorption on fibrous silica gel (Santocel C) of methyl alcohol, ethyl alcohol, *n*-propyl alcohol, *n*-butyl alcohol and *n*-amyl alcohol.

and oriented adsorption perpendicular to surface, the specific surface areas calculated are all nearly the same. Assuming oriented adsorption parallel to surface, the specific surface areas obtained are not the same. The value increases from methyl to *n*-amyl alcohol. It follows from these results that adsorption of the five linear aliphatic normal alcohol molecules is completely of oriented type and the molecules are held perpendicular to the gel surface.

The shapes of the adsorption isotherms of the alcohols are significant. After the initial adsorption due to the formation of monolayer there is no appreciable increase in adsorption with increase in relative vapour pressure upto about 0.75. Above this, there is steep rise. These indicate that pores in fibrous silica gel are mainly macro and surface open. On such a surface completely oriented adsorption is easily possible whereas in micropores it is likely to be obstructed. The existence of completely oriented adsorption of the alcohol molecules on the surface of fibrous silica gel is indeed a very interesting and striking conclusion. Evidences of oriented adsorption of molecules on solid surfaces are not many, though oriented adsorption of molecules in films on liquid surface is well known and well established.

The permanent and reproducible hysteresis loops obtained with the five alcohols are explained in the light of the ink bottle or cavity theory<sup>5,7</sup> of hysteresis. Sorption-desorption hysteresis is due to entrapping of liquid sorbate by cavities with constricted necks.

TABLE I

Specific surface of fibrous silica gel considering alcohol molecules as spherical and linear

	Molecule as spherical		Molecules as linear		Specific surface in m <sup>2</sup> per gm. of gel		
	Diameter D spherical in Å	Cross- section in Å <sup>2</sup>	Cross- section in Å <sup>2</sup>	Area of side in Å <sup>2</sup>	Molecules as spherical	Linear molecules perpendicular to surface	Linear molecules parallel to surface
Methyl alcohol	..	4.6	21.2	20.7	21.4	65.5	64.1
Ethyl alcohol	..	5.2	27.0	20.7	30.9	63.4	48.5
<i>n</i> -Propyl alcohol	..	5.6	31.4	20.7	38.5	86.7	57.2
<i>n</i> -Butyl alcohol	..	6.0	36.0	20.7	47.5	103.4	59.4
<i>n</i> -Amyl alcohol	..	6.3	40.2	20.7	55.0	175.4	57.3

Assuming the alcohol molecules to be spherical, the specific surface areas are calculated for the 5 alcohols and these are not the same. The value increases from methyl to *n*-amyl alcohol. Assuming the molecules as linear

According to cavity theory of hysteresis, every point on the sorption curve enclosing the hysteresis loop denotes the cavity radius and every point on the desorption curve cavity neck radius. The point of inception of

the hysteresis loop indicates the smallest neck radius. In fibrous silica gel, the smallest neck radius and the predominant body and neck radii of cavity are 31.0, 380.0 and 150.0 Å respectively. According to de Boer's classification<sup>8,9</sup> of hysteresis loops, the hysteresis loop of fibrous silica gel is of type A and the capillaries in the gel are cylindrical in shape.

There has been a gradual variation in the shape and shift in the position of the hysteresis loop and decrease in total sorptive capacity at saturation pressure from methyl alcohol to *n*-amyl alcohol. The isotherm of methyl alcohol rises asymptotically to the saturation pressure ordinate whereas the isotherm of *n*-amyl alcohol cuts the saturation pressure ordinate at an angle. The volumes of methyl, ethyl, *n*-propyl, *n*-butyl, *n*-amyl alcohols taken are 33.0, 33.3, 38.7, 19.0 and 21.0 c.c. per 100 gm. of gel respectively.

Gregg<sup>9</sup> has discussed the effect of contact angle of the sorbate on the shape of the sorption isotherm. In the application of Kelvin equation to sorption isotherm, the contact angle is ordinarily assumed to be zero, if the surface is free from impurities. This is true of liquids like water whose contact angle is zero and whose isotherm is asymptotic to the saturation pressure ordinate. But with liquids which have definite contact angle, the isotherm intersects the ordinate at an angle. The asymptotic nature of methyl alcohol isotherm indicates almost indefinite large uptake of sorbate at saturation pressure. From this the contact angle of methyl alcohol on the gel surface may be assumed to be zero. The interception of the *n*-amyl alcohol isotherm at an angle with the saturation pressure ordinate indicates the existence of a definite contact angle. Considering the gradual changes in the shapes of sorption and desorption isotherms, the hysteresis loops, the total sorption value at saturation pressure of the five alcohols—methyl, ethyl, *n*-propyl, *n*-butyl and *n*-amyl—on fibrous silica gel it follows that there is steady increase in contact angle from methyl to amyl alcohol. A search of the literature on contact angle was made and values of

contact angles of the five alcohols could not be obtained. Fox and Zisman<sup>10</sup> have shown that for many of liquids on solids, the contact angle decreases with decreasing surface tension of the liquid. The values of surface tension<sup>11,12</sup> of the methyl, ethyl, *n*-propyl, *n*-butyl and *n*-amyl alcohols are 21.1, 21.45, 22.55, 23.35 and 24.3 dynes per cm. at 35° C. respectively. In the light of Fox and Zisman's conclusion, these values indicate that the contact angle increases from that of methyl alcohol to *n*-amyl alcohol.

The foregoing studies reveal the existence of oriented adsorption of alcohol molecules in the monolayer on the surface of fibrous silica gel and the effect of contact angle of the alcohols on the shapes of the isotherms and the hysteresis loops.

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1. Brunauer, S., Emmett, P. H. and Teller, E., *J. Am. Chem. Soc.*, 1938, **60**, 309.
2. Chester, L. Jones, *Paint Ind. Mag.*, 1947, **62**, 390.
3. Lloyd, D. Shand, *Official Digest Federation Paint and Varnish Production Clubs*, 1948, **277**, 175; *C.A.*, 1948, **42**, 4368.
4. Puddington, I. E., *Anal. Chem.*, 1949, **21**, 316.
5. Subba Rao, K., *J. Phys. Chem.*, 1941, **45**, 500.
6. Moelwyn Hughes, E. A., *Kinetics of Reactions in Solutions*. Clarendon Press, Oxford, 1947, p. 7.
7. McBain, J. W., *J. Am. Chem. Soc.*, 1935, **57**, 699.
8. de Boer, J. H., *The Structure and Properties of Porous Materials*, Butterworth, London, 1958, p. 68.
9. Gregg, S. J. and Sing, K. S. W., *Adsorption, Surface Area and Porosity*, Academic Press, London and New York, 1967, p. 172.
10. Fox, H. W. and Zisman, W. A., *J. Colloid Sci.*, 1950, **5**, 514; 1952, **7**, 109.
11. Timmermans, J., *Physico-Chemical Constants of Pure Organic Compounds*, Elsevier Publishing Co., Inc. 1950.
12. *Hand-Book of Chemistry and Physics*, 44th Ed. Chemical Rubber Publishing Company, Cleveland, Ohio, 1963.

# OCCURRENCE AND ISOLATION OF THERMOPHILIC FUNGI

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THE fungi which thrive at temperatures of 50° C. and higher but are unable to grow at 20° C. have been called thermophilic. Thirteen species of such fungi belonging to 9 genera were monographed for the first time by Cooney and Emerson in 1964. Since then new species and additional sources of occurrence of thermophilic fungi have been recorded (Apinis, 1963; Fergus, 1964; Apinis and Eggins, 1966; Semeniuk and Carmichael, 1966; Okafur, 1966; Apinis and Pugh, 1967). There appears to be no report of such fungi from India. This communication reports on the thermophilic fungi isolated from samples collected locally.

The fungi were isolated from dung of herbivores, compost and sewage manure. Samples of these substrates were placed in moist containers and incubated at 40-60° C. for periods up to two weeks to provide enrichment environment for thermophilic microflora. Fungi were then isolated on nutrient media to which streptomycin or crystal violet was added to prevent bacterial growth at 45-50° C. Yeast-Starch agar (YpSs) (Cooney and Emerson, 1964) proved the best medium for growth and reproduction of thermophilic fungi. That fungi isolated were thermophilic and not thermotolerant was proved by their inability to grow at 20° C. on YpSs, oat meal and Czapek's agar. The fungi isolated are listed in Table I.

In general morphology, cultural characteristics and temperature requirements for growth of all isolates agreed closely with those described by Cooney and Emerson (1964). Although the present isolate of *Talaromyces thermophilus* Stolk (Fig. 1) did not produce the perfect stage, however, the close resemblance of its imperfect stage with the diagnosis left no doubt that this is the same fungus which has synonymy of *Penicillium duponti* (Griffon et Maublanc and *Talaromyces duponti* (Griffon et Maublanc) Emerson (*nomen invalidum*) Cooney and Emerson (1964) had reported that this fungus produces cleistothecia on nutrient media under conditions of reduced oxygen tension whereas they are profusely formed on moist, chopped guayule shrub. According to Stolk (1965) cleistothecia are not produced on

agar media but are regularly formed on sterilized oat grains at 45° C. However, present attempts to induce the development of cleistothecia on sterilized oats or wheat straw and other plant materials did not succeed. This fungus often showed the presence of swollen cells, with smooth walls borne singly on sympodially branched or unbranched hypha in the substrate mycelium (Fig. 2). Furthermore, certain hyphal cells were conspicuously swollen towards one end of the septum (Fig. 3). These features have not been mentioned by Cooney and Emerson (1964).

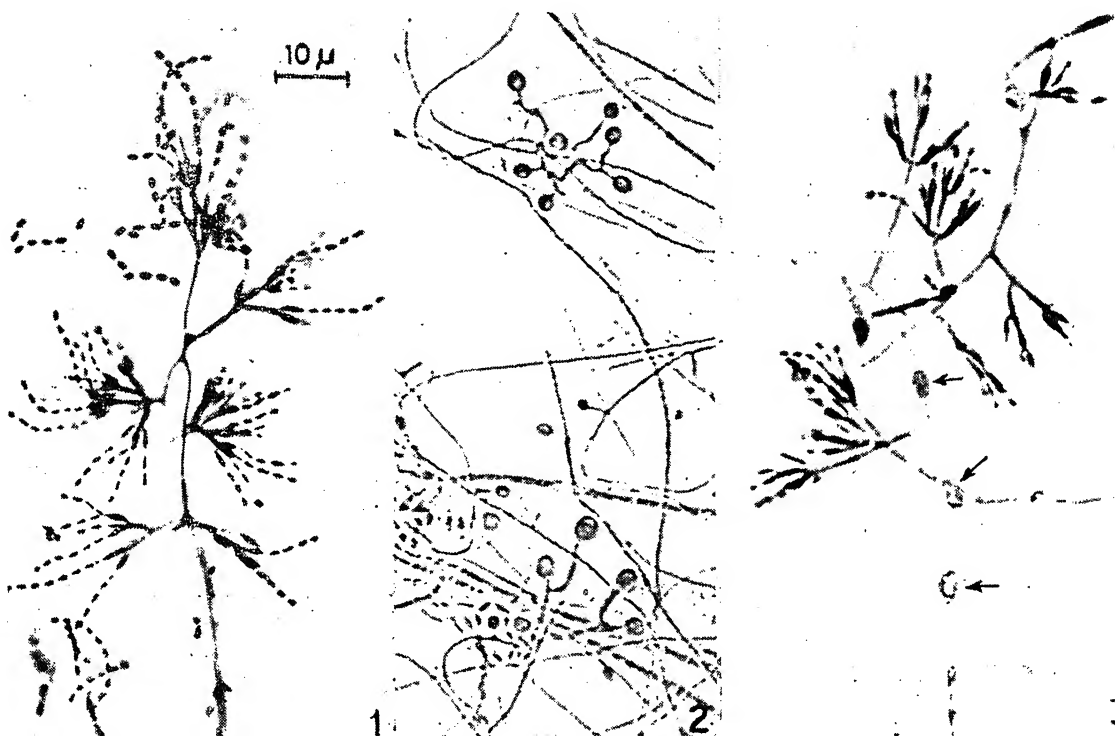
TABLE I  
Occurrence and temperature relation of thermophilic fungi

Fungi	Growth temperature (°C.)		Substrate
	Mini-	Maxi-	
	mum	mum	
<i>Chaetomium thermophile</i>			
La Touche			
var. <i>coprophile</i> Cooney & Emerson	27	58	Dung
var. <i>dissitum</i> Cooney & Emerson	27	58	Dung, manure
var. <i>thermophile</i> La Touche	27	58	Dung, compost
<i>Hunnicola ins lens</i> Cooney & Emerson	23	55	Compost, manure
<i>H. lanuginosa</i> (Griffon et Maublanc) Bunce	30	60	Dung, compost
<i>H. stellata</i> Bunce*	..	..	Compost
<i>Malbranchea pulchella</i> Sacc. & Penzig var. <i>sulfurea</i> (Miehe) Cooney & Emerson	27	55	"
<i>Talaromyces thermophilus</i> Stolk	30	60	Dung, compost

\* Not isolated in culture.

In addition to fungi listed in Table I, three other fungi, *Absidia ramosa*, *Aspergillus fumigatus*, and *Chrysosporium* sp., capable of growing at 40-45° C., were isolated from compost. These were capable of growing below 20° C. although optimum growth occurred at about 40° C. They may be considered psychrotolerant.

The incubation of samples from compost, dung and manure in moist containers at 40-60° C. often resulted in mycelial growth and



FIGS. 1-3. *Talaromyces thermophilus* Stolk. Fig. 1. Conidiophores. Fig. 2. Swollen cells resembling aleuriospores in substrate mycelium. Fig. 3. Hyphal swelling (indicated by arrows).

sporulation of some thermophilic fungi. Particularly, the partially decomposed materials from compost (chiefly of garden and kitchen wastes) supported profuse mycelial growth of *Humicola insolens*, *H. lanuginosa* and *Talaromyces thermophilus*. Microscopic examination of decomposing material also revealed *H. stellata* which, however, could not be obtained in culture.

Measurements of temperature in the compost confirmed that higher temperatures required for growth of thermophiles exist in nature. Temperatures 5 to 20° C. higher than the ambient temperature were recorded inside a compost during monsoon season when the microbial decomposition of organic matter appeared to be at maximum due to the high level of moisture present therein. Temperature was highest (45–50° C.) in those sections of the compost where the decomposable material was relatively fresh. *H. insolens*, *H. lanuginosa*, *T. thermophilus* and *Malbranchea pulchella* var. *sulfurea* were conspicuous in the compost. These observations support the suggestion of Cooney and Emerson (1964) that thermophilic

fungi are importantly involved in compost action.

The possibility was considered that complex nutrients in natural substrata may support growth of these fungi at lower temperatures than the media commonly used in the laboratory. *H. lanuginosa* and *T. thermophilus* did not grow at 20° C. on nutrient media containing vitamins, growth hormones, complex nutrients such as coconut milk and yeast extract even after prolonged incubation. Addition of extracts of composting plant material was also ineffective in inducing growth at 20° C. of all thermophiles isolated except *H. insolens*. Present isolate of the fungus grew well at 20° C. after a lag of 5 days and sporulated on an agar medium containing an extract of decomposing plant tissue, yeast extract, peptone,  $\text{KH}_2\text{PO}_4$ ,  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  and sucrose. Recently, it has been reported that fungi which grow luxuriantly on a sucrose-salt medium at 50° C. but fail to grow on it below 30° C. will grow well at 22° C. on complex natural media (Tendler, Kornberg and Nishimoto, 1967). A requirement for high

temperature may then be eliminated by nutritional environment.

This study is in agreement that thermophilic fungi have an ubiquitous distribution. However, in the present study only such sources were explored where microbial thermogenesis itself produces temperature favouring thermophiles. Future studies in the tropics should explore surface soils and pond waters to determine the frequency of occurrence of thermophiles in such places.

Thanks are due to University Grants Commission for the award of a Senior Research Fellowship, and to Professor D. G. Cooney of University of Nevada for sending a culture of

*Chaetomium thermophile* var. *dissitum* for comparison.

1. Apinis, A. E. *Nova Hedwigia*, 1963, **5**, 57.
2. — and Eggins, H. O. W., *Trans. Br. mycol. Soc.*, 1966, **49**, 629.
3. — and Pugh, G. J. F., *Mycopath. Mycol. appl.*, 1967, **33**, 1.
4. Cooney, D. G. and Emerson, R., *Thermophilic Fungi*, W. H. Freeman & Co., San Francisco, 1964, p. 188.
5. Fergus, C. L., *Mycologia*, 1964, **56**, 267.
6. Okafur, N., *Nature*, 1966, **210**, 220.
7. Semenik, G. and Carmichael, J. W., *Can. J. Bot.*, 1966, **44**, 105.
8. Stolk, Amelia C., *Antonie van Leeuwenhoek*, 1965, **31**, 262.
9. Tendler, M. D., Korman, S. and Nishimoto, Margaret, *Bull. Torrey bot. Club*, 1967, **94**, 175.

## RESONANCE ENERGIES OF TRICARBONYLARENECHROMIUMS

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THE order of stability of the series of  $\pi$ -complexes, the chromium tricarbonyl derivatives of benzene, biphenyl and phenanthrene seems on primary considerations to depend on the  $\pi$ -bonds in the series. Delocalisation of  $\pi$ -electrons takes place extensively in these compounds as manifested by their dipole moments,<sup>1</sup> infrared spectra<sup>2</sup> and other properties.<sup>3</sup> In biphenyl and phenanthrene there are neighbouring ring  $\pi$ -electrons and the extent of participation of such electrons in the bonding becomes important. The Effective Atomic Number (E.A.N.) rule does not permit any such participation but one of us has suggested that in molecular orbital theory the interaction of all the  $\pi$ -orbitals must be taken into account.<sup>4</sup> Thus it is possible to explain the greater stability of phenyl substituted complexes such as tricarbonyl- $\pi$ -tetraphenylcyclobutadieneiron.<sup>5</sup> The fact that in both tricarbonyl- $\pi$ -biphenylchromium and tricarbonyl- $\pi$ -phenanthrenechromium planar structures are maintained<sup>6</sup> and that considerable delocalisation takes place in free biphenyl and phenanthrene indicates the necessity of including the interaction of all  $\pi$ -electrons.

In view of this, we have used semiempirical molecular orbital theory for obtaining the resonance energies of the arene-metal fragments in these complexes. The interaction of all the  $\pi$ -electrons of the respective arene have been included in such calculations. X-ray work has shown that the aromatic moieties in these complexes are planar<sup>6</sup> but there are considerable and random variations of the C-C distances. Hence planar structures are assumed for the aromatic moieties with all the C-C distances taken as 1.39 Å. The inter-ring bond in biphenyl is 1.48 Å.<sup>7</sup> The C-Cr distance is 2.2 Å, the carbon atoms being those of the ring to which the chromium is bound. Further, in the phenanthrene complex the bonding is to one of the end rings.<sup>8</sup>

The highest filled levels amongst the MO's of the arenes are identified with the corresponding ionisation potentials:<sup>9</sup>

biphenyl	$H(4a_1, 4a_1) = -8.27 \text{ e.v.}$
phenanthrene	$H(4a_1, 4a_1) = -8.03 \text{ e.v.}$

Other levels are calculated with respect to these energies. The coulomb terms are taken from Berry's spectroscopic data:<sup>10</sup>

$H(4p, 4p)$	$= -3.86 \text{ e.v.}$
$H(4s, 4s)$	$= -5.76 \text{ e.v.}$
$H(3d, 3d)$	$= -6.76 \text{ e.v.}$

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The group overlap integrals were calculated from tables as in earlier work.<sup>11</sup> An example formula for the interaction of a totally symmetric orbital and the chromium  $4p_z$  orbital is

$$S(\psi, 4p_z) = \sum_{i=1}^m C_i \{ S_i (2p_\sigma 4p_\sigma) \cos^2 \theta_i \\ - S_i (2p_\pi 4p_\pi) \sin^2 \theta_i \}$$

where  $C_i$  is the coefficient of the  $i$ -th carbon atom in the given molecular orbital, and  $\theta_i$  is the angle between the  $Z$ -axis and  $M-C_i$  vector;  $m=12$  and  $14$  respectively for biphenyl and phenanthrene.

The secular determinant is next set up in terms of the group overlap integrals and coulomb terms:

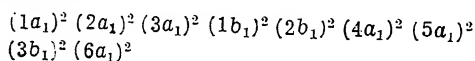
$$|H_{ij} - E| = 0$$

where  $H_{ij}$  is the resonance integral between the orbitals  $\psi_i$  and  $\psi_j$  and  $H_{ii}$  is the coulomb term of the orbital with ' $i$ ' and ' $j$ ' representing the different arene and chromium  $3d$ ,  $4s$ ,  $4p$  orbitals.  $H_{ij}$  was evaluated with the assumption,  $H_{ij} = kS_{ij}$ ,  $S_{ij}$  being the group overlap integral and for  $k=3, 5, 7, 9$  and  $11$  e.v.

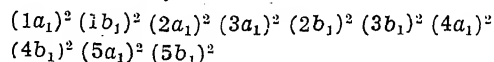
The solution in the case of biphenyl-Cr involved the solving of  $14 \times 14 (A_1)$  and  $7 \times 7 (B_1)$  matrices whereas for phenanthrene-Cr, a  $23 \times 23$  matrix had to be solved. The solutions were carried out on an I.B.M. 1620 computer and the energies for the case  $k=3$  were as follows:

Biphenyl-Cr		Phenanthrene-Cr	
	e.v.		e.v.
$1a_1$	-12.24	$1a_1$	-12.66
$2g_1$	-11.25	$1b_1$	-11.47
$3a_1$	-9.97	$2a_1$	-10.41
$1b_1$	-9.12	$3a_1$	-9.94
$2b_1$	-9.00	$2b_1$	-9.50
$4a_1$	-8.43	$3b_1$	-8.59
$5a_1$	-6.79	$4a_1$	-8.15
$3c_1$	-6.76	$4b_1$	-6.86
$6a_1$	-6.76	$5a_1$	-6.78
		$5b_1$	-6.76

The order of energies is the same for all  $k$  values and the electronic configurations of the arene-metal fragments in the two cases are biphenyl-Cr:



phenanthrene-Cr:



The resonance energies are as given below. The resonance energies for benzene-Cr<sup>12</sup> are also given:

$k$	Biphenyl-Cr (e.v.)	Phenanthrene-Cr (e.v.)	Benzene-Cr (e.v.)
3	3.21	4.02	3.82
5	5.04	6.86	6.52
7	7.27	10.38	9.98
9	10.45	14.32	13.83
11	12.06	18.56	17.97

This gives the order as phenanthrene-Cr > benzene-Cr > biphenyl-Cr. Experimentally it has been found that the phenanthrene- and the benzene-complexes form more easily and in higher yields than the biphenyl-complex. This criterion of the ease of formation and yield is not reliable because the complexes that form easily, e.g., aniline-complex are rather unstable. Accurate measurement of the ring-metal frequency would be helpful but a conclusive assignment of the frequency is difficult. Methods of thermochemistry and photochemistry seem to be important but have not been tried for this case.

- Sutton and Randall, *Proc. Chem. Soc.*, 1959, p. 93; Fischer, E. O. and Schreiner, S., *Chem. Ber.*, 1959, 92, 938.
- Brown, D. A. and Sloan, H., *J. Chem. Soc.*, 1962, p. 3849; Fischer, R. D., *Chem. Ber.*, 1960, 93, 165.
- Whiting, M. C. and Nicholls, B., *J. Chem. Soc.*, 1959, p. 551; Brown, D. A. and Raju, J. R., *J. Chem. Soc. (A)*, 1966, p. 40.
- Brown, D. A., *J. Inorg. Nuclear Chem.*, 1960, 13, 212.
- Dodge, R. P. and Schomaker, V., *Nature*, 1960, 186, 798.
- (a) Allegra, G., *Chem. Abs.*, 1962, 57, 4133 ii; *C.A.*, 55, 8992 a; (b) Deuschel, H. and Hoppe, W., *Acta Cryst.*, 1964, 17, 800.
- Dhar, J., *Indian J. Phys.*, 1936, 7, 43.
- Deuschel, H. and Hoppe, W., *Acta Cryst.*, 1964, 17, 800; Brown, D. A. and Raju, J. R., *J. Chem. Soc. (A)*, 1966, p. 1617.
- Streitwieser, A. Jr., *Molecular Orbital Theory for Organic Chemists*, J. Wiley & Sons, New York, p. 191.
- Berry, J. *Chem. Phys.*, 1961, 35, 29.
- See for e.g., Brown, D. A. and Sloan, H., *J. Chem. Soc.*, 1962, p. 3849.
- Gogan, N., *Thesis*, National University of Ireland, Dublin, 1965.

## LETTERS TO THE EDITOR

### RELATIVE MASS IN GENERAL RELATIVITY

A PARTICLE of constant proper mass  $m_0$  is said to have relative mass  $m$  as given by

$$m_0 \frac{dt}{ds} = m. \quad (1)$$

It is the distinction between the co-ordinate time  $t$  and the proper time  $s$  that brings out the difference between proper and relative mass. Using the usual form of the Riemannian space-time metric with  $i=1, 2, 3$  for the space co-ordinates and  $i=4$  for  $t$  we can write

$$\left(\frac{dt}{ds}\right)^2 = \frac{m^2}{m_0^2} = (g_{ij} \dot{x}^i \dot{x}^j)^{-1} \quad (2)$$

where and in what follows an overhead dot denotes a differentiation with regard to  $t$ . (2) shows how the motion and the field potentials affect the relative mass. It gives for the usual metric of special relativity the well-known result

$$m = m_0 (1 - u^2)^{-\frac{1}{2}} \quad (3)$$

in the usual notation.

The test particles trace non-null geodesics satisfying the equations

$$\frac{d^2 x^i}{ds^2} + \Gamma_{jk}^i \frac{dx^j}{ds} \frac{dx^k}{ds} = 0 \quad (4)$$

of which the fourth runs as follows:

$$\frac{d^2 t}{ds^2} + \Gamma_{jk}^4 \dot{x}^j \dot{x}^k \left(\frac{dt}{ds}\right)^2 = 0. \quad (5)$$

Thus

$$\frac{d}{dt} \log m + \Gamma_{jk}^4 \dot{x}^j \dot{x}^k = 0. \quad (6)$$

The three remaining equations given by (4) can now be expressed as

$$\frac{d}{dt} (m \dot{x}^i) + m \Gamma_{jk}^i \dot{x}^j \dot{x}^k = 0, \quad i = 1, 2, 3. \quad (7)$$

The appearance of the relative mass  $m$  in (7) in a form which bears comparison with the Newtonian equations may be noted. Since the equations of non-null geodesics are used for describing the planetary motion the role of  $m$  in (7) assumes importance.

For certain metrics (5) provides an integral apart from (2). For Schwarzschild's metric satisfying

$$R_{ij} = \lambda g_{ij}$$

we have

$$\begin{aligned} ds^2 = & - \left(1 - \frac{2M}{r} - \lambda \frac{r^2}{3}\right)^{-1} dr^2 \\ & - r^2 (d\theta^2 + \sin^2 \theta d\phi^2) \\ & + \left(1 - \frac{2M}{r} - \lambda \frac{r^2}{3}\right) dt^2 \end{aligned} \quad (8)$$

providing the integral

$$\frac{dt}{ds} \left(1 - \frac{2M}{r} - \lambda \frac{r^2}{3}\right) = c$$

which means

$$m \left(1 - \frac{2M}{r} - \lambda \frac{r^2}{3}\right) = m_0 c, \quad (9)$$

where  $c$  depends upon the initial conditions of motion. While considering the variation of  $m$  and its possible extreme values as given by (9), one must remember that the conditions under which the geodesic postulate is valid must not be violated. If  $M=0$  in (9) we get a formula for the relative mass of a particle in de Sitter's universe. Following the well-known static solution for a particle of mass  $M$  and charge  $e$  ( $\lambda$  being zero) we get, corresponding to (9),

$$m \left(1 - \frac{2M}{r} + 4\pi \frac{e^2}{r^2}\right) = m_0 c. \quad (10)$$

For the non-static universe given by

$$\begin{aligned} ds^2 = & - R^2(t) [dx^2 + \sin^2 x (d\theta^2 + \sin^2 \theta d\phi^2)] \\ & + dt^2 \end{aligned} \quad (11)$$

we have from (5)

$$\begin{aligned} \frac{d^2 t}{ds^2} + R\dot{R} [\dot{x}^2 + \sin^2 x (\dot{\theta}^2 + \sin^2 \theta \dot{\phi}^2)] \\ \times \left(\frac{dt}{ds}\right)^2 = 0, \end{aligned} \quad (12)$$

while (11) gives

$$\left(\frac{ds}{dt}\right)^2 = 1 - R^2 [\dot{x}^2 + \sin^2 x (\dot{\theta}^2 + \sin^2 \theta \dot{\phi}^2)]$$

so that

$$\frac{d^2 t}{ds^2} + \left[\left(\frac{dt}{ds}\right)^2 - 1\right] \frac{\dot{R}}{R} = 0$$

or

$$\left(\frac{dt}{ds}\right)^2 = 1 + \frac{c}{R^2}$$

that is,

$$m^2 - m_0^2 = m_0^2 \frac{c}{R^2} \quad (13)$$

$c$  is to be determined by the initial conditions. (13) shows how the relative mass of every particle bears witness to the contemporary (in the sense of the cosmic time  $t$ ) radius  $R$  of

the universe, which may be contracting, expanding or oscillating. The cosmic behaviour would be reflected in the relative mass of every inertial particle, reminding us of Mach's principle.

When the metric is expressed in the geodesic form so that  $g_{44}=1$  and  $g_{i4}=0$  for  $i=1, 2, 3$  (6) can be expressed as

$$\frac{\dot{m}}{m} = \frac{1}{2} \left( \frac{\partial}{\partial t} g_{ij} \right) \dot{x}^i \dot{x}^j \quad (14)$$

which has to be interpreted along with (2). It is easy to see that elegant formulae like (9), (10), (13) and (14) can be deduced for several other gravitational metrics. The formulae would be valid to the extent that the effect of the particle on the field described by the metric can be ignored.

The University of Poona, V. V. NARLIKAR.  
Poona-7, April 15, 1968.

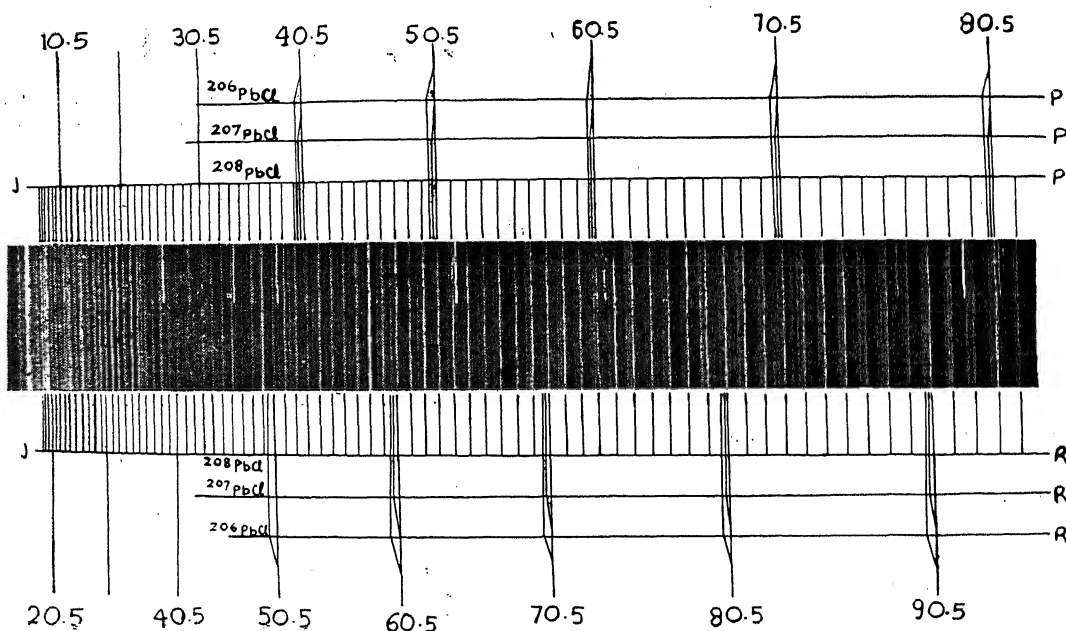
### ROTATIONAL ANALYSIS OF THE A-X BANDS OF PbCl MOLECULE

RECENTLY Rao and Rao<sup>1</sup> presented the rotational analysis of the four bands—(4, 0), (6, 0), (1, 1) and (3, 1), lying in the region 4300-4700 Å of the A-X system of PbCl. We obtained a well-resolved structure of this band

system using a 35 ft. concave grating spectrograph in which quite sharp and clear isotopic lines due to  $^{208}\text{Pb}^{35}\text{Cl}$ ,  $^{207}\text{Pb}^{35}\text{Cl}$  and  $^{206}\text{Pb}^{35}\text{Cl}$  were observed in the (6, 0) band. A new rotational analysis for these bands has been proposed and revised constants are obtained.

The emission spectrum of PbCl has been excited in an electrodeless discharge tube by a Raytheon Microtherm Oscillator (2,450 mcs./sec., power 125 watt). It was found desirable to heat the sample externally to get a bright glow. The spectrum was recorded, in the region 4300-4600 Å, in the second order with a dispersion of 0.33 Å/mm. Kodak II-O plates were used and with a slit-width of 25  $\mu$  an exposure of four hours was found satisfactory. Atomic spectrum of thorium, excited in an electrodeless discharge tube, was used as the reference spectrum. Measurements of the sharp lines are believed to be accurate to  $0.03 \text{ cm}^{-1}$ .

Because of the greater isotopic separation, the (6, 0) and (4, 0) bands were analysed in this study. A reproduction of the (6, 0) band is given in Fig. 1. Both the bands show only two branches—a single R and a single P. The two branches are exactly superposed and separate only at very high J values. The usual



(6,0) Band



procedure has been adopted for evaluating the J numbering and the rotational constants. The rotational and the molecular constants thus obtained are collected in Tables I and II.

TABLE I  
Rotational constants of A-X bands of  $^{208}\text{Pb}^{35}\text{Cl}$

$v', v''$	Band origin ( $\text{cm}^{-1}$ )	$B_0''$ ( $\text{cm}^{-1}$ )	$B_0'$ ( $\text{cm}^{-1}$ )
6, 0	23166.70	0.11862	0.10270
4, 0	22727.67	0.11862	0.10375
Constants obtained by earlier workers <sup>1</sup>			
6, 0	23165.42	0.1167	0.1005
4, 0	22725.70	0.1167	0.1017

TABLE II  
Molecular constants in the X  $^{2}\text{H}_1$  and A  $^{2}\Sigma^+$  states of  $^{208}\text{Pb}^{35}\text{Cl}$

X $^{2}\text{H}_1$ State	A $^{2}\Sigma^+$ State
$B_0 = 0.11862 \text{ cm}^{-1}$	$B_0 = 0.10716 \text{ cm}^{-1}$
$r_0 = 2.179 \text{ \AA}$	$r_0 = 2.293 \text{ \AA}$
$I_0 = 235.904 \times 10^{-10} \text{ gm.cm}^2$	$I_0 = 261.132 \times 10^{-10} \text{ gm.cm}^2$
	$a_0 = 0.000525 \text{ cm}^{-1}$

In the (6, 0) band (Fig. 1) we can see groups of three closely-spaced lines continuing from lower to higher J values. The relative separation among the lines in a group is constant throughout and is equal to the vibrational isotopic separation (because the rotational isotopic separation is negligible). It may be mentioned that in the spectrum recorded earlier,<sup>1</sup> the three lines in each group were not resolved and a broad diffuse line was observed; one edge of which was taken to be forming the P branch and the other to be forming the R branch.

For most of the mono-fluorides of IV group, it has been experimentally verified that the A-X<sub>1</sub> band system is due to the transition  $^{2}\Sigma^+ - ^{2}\text{H}_1$ .<sup>2,5</sup> The structure in this case also suggests that a case (c) equivalent of  $^{2}\Sigma^+ - ^{2}\text{H}_1$  represents the band system.

The authors are grateful to Prof. N. L. Singh for his interest in the work.

Dept. of Spectroscopy, O. N. SINGH  
Banaras Hindu University, I. S. SINGH  
Banaras, December 9, 1967.

## INFLUENCE OF CRYSTAL DEFECTS ON PHOTOANNEALING OF CHEMICAL RADIATION DAMAGE

MOHANTY AND NAIR<sup>1</sup> have recently shown that chemical radiation damage in lead nitrate recovers on exposure to light in the visible region. It is well known that crystal defects render a substance more susceptible to thermal annealing.<sup>2</sup> The present work shows that defects influence also the photoannealing of chemical radiation damage.

Two samples of 85 to 100 mesh size lead nitrate crystals from the same batch were irradiated, one with 50 Mrad of  $^{60}\text{Co}$   $\gamma$ -rays at the dose rate of about 1.5 Mrad hr.<sup>-1</sup> and the other close to the core (temperature  $< 45^\circ\text{C}$ .) of the Bhabha Atomic Research Centre water moderated reactor, Apsara so as to receive the above dose of  $\gamma$ -rays at the dose rate of about 10 Mrad hr.<sup>-1</sup> and, in addition,  $5 \times 10^{15}$  nvt fast and  $2.2 \times 10^{16}$  nvt slow neutrons. The two irradiated samples thus differed in that whereas in the sample irradiated with  $\gamma$ -rays alone the damage was almost entirely chemical, in the sample irradiated with  $\gamma$ -rays plus neutrons, in addition to the chemical damage, a considerable concentration of displacements were present having been generated by the knock-on collisions of chiefly the fast neutrons.

The procedures employed for studying the kinetics and the wavelength dependence of photoannealing were the same as described previously.<sup>1</sup>

Typical plots of the damage nitrite concentration versus the time of illumination are given in Fig. 1. The plots are linear as for a first order process. The material irradiated with  $\gamma$ -rays plus neutrons undergoes photoannealing at a greater rate than that irradiated with  $\gamma$ -rays alone; the velocity constants are respectively 0.000432 and 0.000173 hr.<sup>-1</sup> It is seen from Fig. 2 that for a given light frequency the recovery is also greater for reactor irradiation than for pure  $\gamma$ -rays. The recovery in both cases is linearly related to the light frequency. It is, however, significant that the threshold frequency for annealing, viz.,  $42 \times 10^{13} \text{ sec}^{-1}$  corresponding to 1.74 eV and 40.1 kcal mole<sup>-1</sup>, is independent of the defect concentration.

The authors thank the Bhabha Atomic Research Centre, Bombay, for assistance with the irradiations.

1. Rao, V. S. and Rao, P. T., *Z. Physik*, 1964, **181**, 58.
2. Barrow, R. F., *Proc. Phys. Soc.*, London, 1962, **79**, 749.
3. —, *Ibid.*, 1958, **71**, 476.
4. Verma, R. D., *Can. J. Phys.*, 1962, **40**, 586.
5. Rao, K. M. and Rao, P. T., *Ibid.*, 1964, **42**, 690.

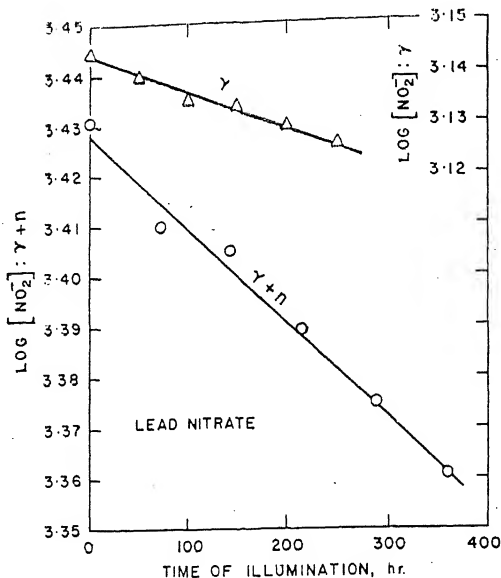


FIG. 1. Kinetics of photoannealing of chemical radiation damage in lead nitrate.

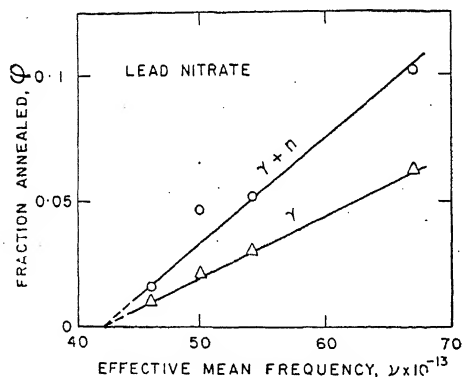


FIG. 2. Dependence of photoannealing on the light frequency.

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Chemistry Laboratory,  
Department of Chemistry,  
Utkal University,  
Bhubaneswar, February 26, 1968.

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## FURTHER INVESTIGATIONS ON THE $\gamma$ -PHASE OF *p*-DICHLOROBENZENE

FOLLOWING the work reported in two earlier communications<sup>1,2</sup> on the NQR observations on the  $\gamma$ -phase of paradichlorobenzene a more detailed study of the Zeeman effect has been made on a number of single crystals of this compound, at different temperatures, with a view to study the changes, if any, in (a) the bond character and (b) the relative orientation of the C-Cl bond during the transition into the  $\gamma$ -phase. A series of measurements have also been made on the frequencies at different temperatures in both the powder and single crystals. Analysis of all the observations has revealed the following new results.

1. The orientation of the field gradient axis, with respect to the laboratory co-ordinate system, for the crystal, grown from melt, in the  $\beta$ -phase, at the laboratory temperature is measured as  $(\theta_z, \phi_z) = (74.2^\circ, 114^\circ)$ . This value is in agreement with that for  $\beta$ -phase, reported by Dean.<sup>3</sup>

2. Zeeman measurements at about  $-15^\circ \text{C}$ . on the single crystals in the  $\gamma$ -phase have shown that the orientation of Z-axis of the field gradient in the Laboratory co-ordinate system is  $(\theta_z, \phi_z) = (117.7^\circ, 89^\circ)$ .

3. The relative orientation of the field gradient axes of the  $\beta$ - and  $\gamma$ -phases is calculated to be  $49.8^\circ$ .

4. Following the method adopted by Meal,<sup>4</sup> the bond character of the C-Cl bond has been estimated for the  $\gamma$ -phase and compared with the corresponding values of the  $\alpha$ - and  $\beta$ -phases reported in literature.

Molecule	C <sup>-</sup> =Cl <sup>+</sup> %	C <sup>+</sup> Cl <sup>-</sup> %
<i>p</i> -dichlorobenzene $\gamma$ -phase (author)	2.37	20.25
<i>p</i> -dichlorobenzene $\alpha$ -phase (Dean)	$2.26 \pm 0.7$	$20.4 \pm 0.7$
<i>p</i> -dichlorobenzene $\alpha$ - and $\beta$ -phases <sup>5</sup>	$1.66 \pm 0.7$	$20.9 \pm 0.7$

It is observed that the changes in the orientation of the field gradient axes do not seem to have given rise to any large changes in the bond character, during the phase transition.

The author is indebted to Prof. K. R. Rao for his valuable guidance. She is thankful to the C.S.I.R., New Delhi, for the award of a Research Fellowship.

1. Mohanty, S. R. and Nair, S. M. K., *Nature*, 1967, 215, 1476.

2. — and —, *Curr. Sci.*, 1967, 36, 536 and references therein.

Magnetic Resonance Labs., B. KANTIMATI,  
Dept. of Physics, Andhra University,  
Waltair, February 29, 1968.

1. Kantimati, B., *Ind. J. pure and applied Phys.*, 1966, 4, 85.
2. —, *Curr. Sci.*, 1967, 36, 40.
3. Dean, C., *Ph.D. Thesis*, Harvard University, Harvard, 1952.
4. Mead, H. C., *J. Chem. Phys.*, 1956, 24, 1011.
5. Shiznko Oyawa and Kikuo Ohi, *J. Phys. Soc., Japan*, 1960, 15, 1064.

## A NEW ALKALOID FROM THE SEEDS OF CROTALARIA STRIATA

*Crotalaria striata* (mucronata) is an erect, herbaceous, Indian shrub found throughout India.<sup>1,2</sup> The seeds of this plant collected near Canton in Southern China were earlier reported<sup>3</sup> to contain an alkaloid, mucronatine,  $C_{18}H_{25}NO_6$ , m.p. 179–181°C.; its structure was however not determined.

In our study, the seeds (5 kg.) procured from Kerala State were coarsely ground and extracted with hot ethanol and the extract concentrated. It was acidified with an equal volume of 10% aqueous citric acid and the remaining ethanol distilled off under reduced pressure. After successive extractions with petroleum ether and ether, the solution was made basic with ammonia and extracted exhaustively with chloroform. The chloroform extract was evaporated yielding a brown gum which answered alkaloid tests and not the test for N-oxides. For purification, its solution in chloroform was treated with petroleum ether, when a pale yellow solid separated. T.L.C. (silica gel G) using methanol as solvent gave a single spot  $R_f$  0.33. Paper chromatography (ascending) using different solvent systems also showed it to be single; (i) *n*-Butanol: acetic acid: water (60:15:25),  $R_f$  0.80; (ii) *n*-Butanol: ammonia: water (30:1:5),  $R_f$  0.93 and (iii) *n*-Butanol saturated with 5% hydrochloric acid,  $R_f$  0.61.

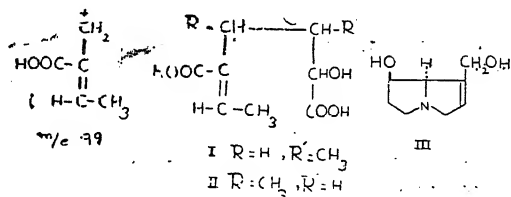
The alkaloid crystallised from ethyl acetate as colourless plates, m.p. 133°C.,  $[\alpha]_D^{20} + 9.6^\circ$  (C, 10.4 mg./ml. of chloroform);  $+ 32.2^\circ$  (C, 12.4 mg./ml. of abs. ethanol). Its analysis agreed with the formula  $C_{19}H_{25}NO_6$ , showed absence of methoxyl and N-methyl groups and the presence of two C-methyl groups.  $\nu_{\text{max}}^{\text{KBr}}$ : 1750 (saturated ester carbonyl), 1725 (unsaturated ester carbonyl) and 1667  $\text{cm}^{-1}$  (double bond). It formed a perchlorate, m.p. 245°C. (d) which analysed for  $C_{19}H_{25}NO_6 \cdot HClO_4$  and a hygroscopic picrate,

On hydrolysis with aqueous barium hydroxide the alkaloid gave a necine and a necic acid. The necine was converted into its hydrochloride and identified as retronecine hydrochloride by mixed melting point and superimposable infra-red with an authentic sample of retronecine hydrochloride.

The necic acid crystallised from ethyl acetate-petroleum ether (40–60°C) as a colourless solid, m.p. 138°C.,  $[\alpha]_D^{25} - 14.0^\circ$  (C, 10 mg./ml. of abs. ethanol) and its analysis agreed with the formula  $C_9H_{14}O_5$  containing two C-methyl groups. In its mass spectrum, the molecular ion peak at  $m/e$  202 was not observed but a peak at  $m/e$  184 was seen due to loss of a water molecule.  $\nu_{\text{max}}^{\text{KBr}}$ : 3520 (hydroxyl), 1735, 1700 (carboxyl) and 1665  $\text{cm}^{-1}$  (double bond). It gave a marked yellow ferric reaction for an  $\alpha$ -hydroxy acid. All these data show that the necic acid and consequently the alkaloid are new, and are therefore named striatic acid and crotastratine respectively.

In the N.M.R. spectrum of the acid, the appearance of a quartet at  $\delta$  6.9 (1H) and a doublet at  $\delta$  1.7 (3H) suggests the presence of  $-\text{OC}-\text{C}=\text{CH}-\text{CH}_3$ . The above  $\delta$  value for

the olefinic proton is consistent only with the *cis* configuration of the hydrogen and carboxyl about the double bond.<sup>4</sup> Further, since striatic acid is an  $\alpha$ -hydroxy acid and does not have in its N.M.R. spectrum, a singlet characteristic of a tertiary methyl, the grouping  $-\text{CH}(\text{OH})-\text{COOH}$  is also indicated. These two could be linked up leading to two possible structures (I and II). Of these, I is supported by its mass spectrum which gives a fragment with value 99 as shown below:



Crotastratine contains an acetyl group as its N.M.R. spectrum showed a singlet integrating to three protons at  $\delta$  2.2; this disappeared in the N.M.R. of striatic acid and in its place I.R. hydroxyl absorption appeared. Hence, in the diester alkaloid, the hydroxyl group of the acid part is acetylated. The way in which acetylated striatic acid is linked up

with retronecine (III) to form crotastratine is under study.

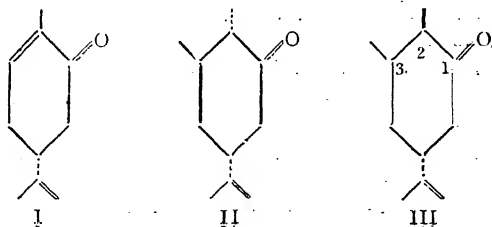
Department of Chemistry, R. N. GANDHI.  
University of Delhi, T. R. RAJAGOPALAN.  
Delhi-7, March 4, 1968. T. R. SESHADRI.

1. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants, C.S.I.R.*, 1956, p. 81.
2. —, Badhwar, R. L. and Ghosh, S., *Poisonous Plants of India*, 1965, 1, 315.
3. Yuan-lung Chu, Chih-chen, Lu and Jen-hung Chu, *Chem. Abst.*, 1964, 61, 8129.
4. Nair, M. D. and Adams, R., *J. Am. Chem. Soc.*, 1960, 82, 3786.

### METHYLDIHYDROCARVONE\*

RECENT interest<sup>1-3</sup> in the addition reactions of carvone prompts us to record our investigations on methyl dihydrocarvone, which was first prepared by Rupe and Liechtenhan<sup>4</sup> by the conjugate addition of methyl magnesium iodide to carvone.

Allinger and Riew<sup>5</sup> have shown that conjugate addition of methyl magnesium iodide to 5-methylcyclohex-2-enone is stereospecific, the reagent approaching the molecule from the side *trans* to the methyl group at C-5. By analogy with the above findings, conjugate addition of methyl magnesium iodide to (—) carvone (I) may be predicted to proceed from the side *trans* to the isopropenyl group to furnish a mixture of epimeric ketones (II) and (III). The addition product from (—) carvone, after equilibration, is likely to yield a mixture containing both the epimers (II) and (III), in significant quantities for the following reasons: (i) ketone (II) has the isopropenyl group axial in the favoured chair conformation whereas ketone (III) has the methyl group at C-3 axial in the favoured chair conformation; (ii) the conformational free energy difference —  $\Delta G^\circ$  for methyl group (1.7 k.cal. per mole)<sup>6</sup> is probably not very much different from that of the isopropenyl group (—  $\Delta G^\circ$  is not known for isopropenyl group but it is considered to be less than that of the isopropyl group<sup>6</sup> for which the value quoted is 2.1 k.cal./mole).



Methyl dihydrocarvone ( $\nu_{\max}$  1720  $\text{cm}^{-1}$ ) prepared by us by the addition of lithium dimethyl copper<sup>7</sup> to (—) carvone is an approximately 1:1 mixture of two ketones on the basis of gas liquid chromatography studies. It was recovered unchanged (as judged by IR spectrum, GLC behaviour, refractive index and rotation) after keeping in contact with *p*-toluene sulphonic acid in ethylacetate solution at room temperature for seven days. It furnished 2,4-dinitrophenyl-hydrazone, m.p. 98–99° (Found: C, 58.61, H, 6.59; N, 16.45;  $\text{C}_{11}\text{H}_{22}\text{O}_4\text{N}_4$  requires C, 58.94; H, 6.40; N, 16.18%) and semicarbazone, m.p. 182–184° (lit.<sup>4</sup> m.p. 180–81°) ( $\alpha_D^{25} = -7$  (c, 5.2 in acetic acid),  $\lambda_{\text{EtOH}}^{\text{EtOH}}$  227  $\text{m}\mu$ ,  $\epsilon$ , 17,500; NMR<sup>†</sup> signals at 9.11, 9.01, 8.92 and 8.81  $\tau$  (6H,  $\text{CH}_3$  on C-2 and C-3), 8.30  $\tau$  (3H,  $\text{CH}_3$  of isopropenyl group) and 5.13  $\tau$  (2H, vinyl protons). Though both 2,4-dinitrophenylhydrazone and semicarbazone were sharp melting the product obtained after regeneration was an approximately 1:1 mixture of two ketones.

Our observations suggest that addition of lithium dimethyl copper to (—) carvone (I) furnishes a mixture of the methyl dihydrocarvones (II) and (III). This suggestion is consistent with previous work.<sup>1-5</sup>

National Chemical Lab.,  
Poona (India),  
March 19, 1968.

E. SISCOVIC.  
A. S. RAO.

\* Communication No. 1158 from the National Chemical Laboratory, Poona, India.

† NMR spectrum was taken in pyridine solution using tetramethylsilane as internal reference on A-60 variant instrument.

1. Ijerassi, C., Schneider, R. A., Vorbrueggen, H. and Allinger, N. L., *J. Org. Chem.*, 1963, 28, 1632.
2. Klein, E. and Chlopf, G., *Tetrahedron*, 1963, 19, 1091.
3. Honwad, V. K., Siscovic, E. and Rao, A. S., *Ind. J. Chem.*, 1967, 5, 234.
4. Rupe, H. and Liechtenhan, K., *Chem. Ber.*, 1906, 39, 1119.
5. Allinger, N. L. and Riew, C. K., *Tetrahedron Letters*, 1966, p. 1269.
6. Eliel, E. L., *Angew. Chem. Internat. Edit.*, 1965, 4, 761.
7. House, H. O., Respass, W. L. and Whitesides, C. M., *J. Org. Chem.*, 1966, 31, 3128.

CHEMICAL COMPONENTS OF  
*ASPARAGUS RACEMOSUS*

*Asparagus racemosus* Willd.<sup>1,2</sup> (Liliaceæ) is a tall climbing undershrub with cladodes and ivory white fragrant flowers in racemes, and bears small berries which are pink-red when fully ripe. It is distributed throughout the tropical and subtropical India and valued much in the Indian indigenous system of medicine under the popular name *Shatavari*; the roots find special use for a number of ailments. Since there is no record of any systematic chemical work on this medicinal plant, we have examined in detail the different parts of the plant and the results are recorded in brief:

**Flowers.**—Fresh flowers of *A. racemosus* growing in Pondicherry were collected during December, 1967 and extracted three times with hot methanol under reflux. The combined extracts were concentrated *in vacuo* to a small volume to remove all the solvent with addition of some water towards the last stages of concentration. The aqueous concentrate on cooling deposited colourless solid, which was filtered and recrystallised from methanol-acetone when it came out as colourless needles, m.p. 86–87°. It gave no colour with ferric chloride, but reduced Tollen's reagent; its acetate melted at 82–83°.

The aqueous filtrate was repeatedly shaken with petroleum ether, ether and ethyl acetate in succession. The residue from the petroleum ether layer yielded some colourless solid, which answered tests for steroids (phytosterol). The concentrate from the ether layer gave tests for flavonol, and on paper chromatography showed single spot corresponding to quercetin. The identity of the pigment was confirmed by comparison of its colour reactions and  $R_f$  values on paper chromatogram in different solvent systems with an authentic sample of quercetin as well as the preparation of its acetate m.p. 195–96° whose mixed melting point with authentic quercetin pentaacetate was undepressed. The ethyl acetate layer on paper chromatography indicated the presence of two flavonoids ( $R_f$  0.46 and 0.71 in *n*-butanol: 27% acetic acid, 1:1 V/V). The components of the total ethyl acetate extract were separated by large scale paper chromatography on Whatman No. 3 filter-papers using the above solvent system. The zones were cut out and eluted with hot methanol and rechromatographed till the pure components with single spot were obtained. The pigment

with the higher  $R_f$  value was identified as hyperoside by direct comparison with an authentic sample of the compound. The eluate containing this component on hydrolysis gave only quercetin and galactose.

The residue from the eluate containing the component with lower  $R_f$  value was crystallised from aqueous ethanol, when pale yellow needles, m.p. 186–88° were obtained. It answered all colour reactions of rutin, and gave  $R_f$  values in different solvent systems agreeing with those recorded<sup>3,4</sup> for rutin. On hydrolysis with 7% sulphuric acid in aqueous alcoholic medium it gave quercetin, glucose and rhamnose. The identity was further confirmed by direct comparison with an authentic sample of rutin from *Cleome chelidonii*.<sup>3</sup> The yield of rutin was about 2.5% on the dry basis of the flowers, and the total flavonoids about 3%.

**Fruits.**—Almost mature fruits (green in colour) on a similar chemical examination was found to contain, by paper chromatography, the same glycosides of quercetin, rutin and hyperoside as in the flowers, but no free quercetin could be identified.

The fully ripe fruits (pink-red in colour) were examined for the presence of anthocyanin pigments; the anthocyanins were extracted with 0.01N methanolic hydrochloric acid and the extract concentrated *in vacuo* and purified by preparative paper chromatography using 1% aq. HCl as the solvent. The two zones developed were separately eluted with 0.01N methanolic HCl and studied by its  $R_f$  values and absorption characteristics. They were found to be cyanidin glycosides; one of them corresponded to cyanidin-3-galactoside ( $\lambda_{\text{max.}}$ : 538 m $\mu$ ) and the other cyanidin-3-glucorhamnoside ( $\lambda_{\text{max.}}$ : 538 m $\mu$ ) from the  $R_f$  values<sup>4,5</sup> in different solvent systems. The total anthocyanin pigment was about 1%.

**Leaves.**—The leaves on working up in similar manner as flowers was found to contain rutin and another flavonoid glycoside with a very high  $R_f$  (0.72) in water.

**Roots.**—Flavonoids were found to be absent in the roots. However, an alcoholic extract of the roots gave strongly positive tests for presence of saponins and on acid hydrolysis yielded small amount of steroid saponin. No asparagine could be isolated.

It is interesting to note that *A. racemosus* contains quercetin and its glycosides parts except the roots, while *A. officinalis* a number of flavonoids<sup>6</sup> distributed in all parts of the plant including the roots. The other

striking difference between the two species is that no asparagine could be isolated from the root of *A. racemosus* while *A. officinalis* contains significant amounts of asparagine.<sup>7</sup> *A. racemosus* is an addition to the list of plants<sup>8</sup> containing the identical glycosides of flavonol and the corresponding anthocyanidin together. The presence of asparagine in *A. officinalis* but its absence in *A. racemosus* suggests that there might be some fundamental differences in the biosynthesis of asparagine involving the utilisation of cyanide<sup>9</sup> in the two species as in the case of *Delonix elata* and *D. regia*.<sup>10</sup>

We thank Prof. Dr. L. Hörhammer, Director, Institute for Pharmaceutical Sciences, University of Munich, Munich for an authentic sample of hyperoside, and Principal Dr. D. J. Reddy for encouragement.

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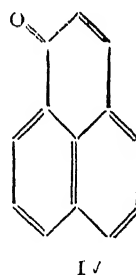
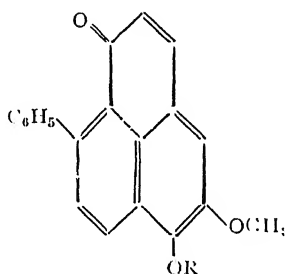
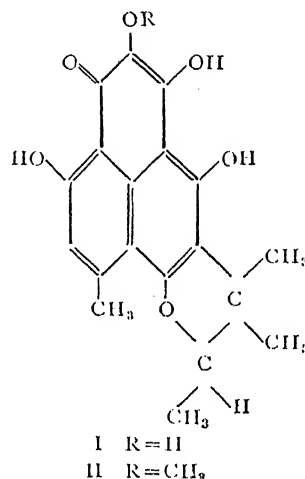
Postgraduate Medical  
Education and Research,  
Pondicherry-6,  
February 29, 1968.

1. *Wealth of India, Raw Materials*, C.S.I.R., New Delhi, 1948, 1, 132.
2. Kirtikar, K. R. and Basu, B. D., *Indian Medicinal Plants*, Lalit Mohan Basu Allahabad, 1933, 4, 2499.
3. Subramanian S. S., Nair, A. G. R. and Nagarajan, S., *Curr. Sci.*, 1965, 34, 246.
4. Harborne, J. B., *Comparative Biochemistry of the Flavonoids*, Academic Press 1967, pp. 32, 69.
5. Halevey, A. H. and Asen, S., *Plant Physiol.*, 1959, 34, 494.
6. Okonenko, V. U. and Krivenchuk, P. Ye., *Chem., Abstr.*, 1967, 66, 4190.
7. Vanquelin, L. N. and Robiquot, P. J., *Ann. Chim.*, 1806, 57, 88.
8. Harborne, J. B., *Arch. Biochem. Biophys.*, 1962, 96, 177.
9. Ressler, C., *Federation Proc.*, 1964, 23, Part I, 1350.
10. Subramanian S. S., Malhotra, A. and Muri, V. V. S., *Curr. Sci.*, 1966, 35, 438.

#### ANTIBACTERIAL PROPERTIES OF PERINAPHTHENONE DERIVATIVES

ATROVENETIN (I), isolated from cultures of *Penicillium atrovenetum*<sup>1</sup> and *Penicillium herquei*<sup>2</sup> was shown to have antibacterial activity,<sup>2</sup> was shown to have antibacterial activity isolated from cultures of *Penicillium herquei*, was devoid of any antibacterial activity. However, deoxyherqueinone (II), atrovnetin 2-methyl ether, obtained from herqueinone by mild reduction with zinc and

acetic acid, was also found to have antibacterial activity.<sup>1</sup> Since both the compounds possessed perinaphthenone nucleus, the structural requirements in the perinaphthenone nucleus for exhibiting antibacterial activity were investigated.



Hæmocorin (III), the only other naturally-occurring perinaphthenone derivative, was reported from the Australian plant, *Hæmodorum corymbosum* by Cooke *et al.*<sup>5</sup> from whom a sample was obtained. 2:4-Dihydroxy perinaphthenone was obtained from the same source. The parent compound perinaphthenone (IV) was from Aldrich Chemical Co. and the other compounds, 2-, 6-, and 9-hydroxy perinaphthenones were synthesised according to standard methods reported in literature.<sup>5-6</sup> 6- and 9-hydroxy perinaphthenones as obtained by the usual procedures were found contaminated with coloured byproducts (TLC on Silica Gel G) and so were purified on a silica gel column. Deoxyherqueinone was included in the tests for a comparative evaluation of the activity.

## ANTIBACTERIAL ACTIVITY

(1) *Filter Disc Method*.—Filter discs (Carl Schleicher and Schuell Co.) were treated with 0.1 ml. of the solutions of test compounds in methanol or chloroform containing 1 mg./ml. The discs were dried in air to remove the solvent and then transferred to *B. subtilis* plates. The plates were left in the refrigerator for 30 minutes and then transferred to 37° C. for incubation overnight.

(2) *M.I.C. Method*: Bacterial cultures of *B. subtilis*, *B. mycoides*, *Staph. aureus* 2377, *Staph. aureus* P<sub>2</sub>O<sub>11</sub> (penicillin-sensitive), *Staph. aureus* H 232 (penicillin-resistant) and *E. coli* were used as test organisms. A fresh 18-hour culture was used as inoculum. Minimum inhibitory concentration was determined by standard tube dilution method. The results were read after overnight incubation at 37° C.

TABLE I  
Sensitivity disc test against *B. subtilis* (MB-34)

No.	Compound	Activity
1	Perinaphthenone	.. ++
2	2-Hydroxy perinaphthenone	.. +
3	6-Hydroxy per naphthenone	.. +++
4	9-Hydroxy perinaphthenone	.. +++
5	2 : 4-Dihydroxy perinaphthenone	.. ++
6	Haemocorin	.. +
7	Haemocorin aglycone	.. +
8	Deoxyherqueinone	.. +++

TABLE II  
Activity against bacterial strains  
(M.I.C. Method mcg./ml.)

No.	Organism	Deoxyherqueinone	Haemocorin	Perinaphthenone	6-Hydroxy perinaphthenone	2 : 4-Dihydroxy perinaphthenone
1	<i>B. subtilis</i> MB-34	1-5	Not tested	5-10	1-10	Not tested
2	<i>B. mycoides</i>	10-50	do.	10-50	1-10	do.
3	<i>Staph. aureus</i> 2377	20-50	20-50	5-10	1-10	10-20
4	<i>Staph. aureus</i> P <sub>2</sub> O <sub>11</sub>	20-50	20-50	50	1-10	10-20
5	<i>Staph. aureus</i> 11232	20-50	10-20	10-50	1-10	10-20
6	<i>E. coli</i>	50	Not tested	50	50	Not tested

## RESULTS AND DISCUSSION

The results of Filter Disc method are given in Table I and the M.I.C. method in Table II. The parent compound perinaphthenone itself

shows activity and all the compounds tested were found active. Of the synthetic compounds 6-hydroxy perinaphthenone was most active. From the above data it is seen that perinaphthenone derivatives possess antibacterial properties which are associated with the perinaphthenone nucleus.

Our sincere thanks are due to Prof. R. G. Cooke of the University of Melbourne for the samples of haemocorin and 2 : 4-dihydroxy perinaphthenone.

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Pimpri, Poona-18, M. V. PANSE.  
February 21, 1968. M. N. WAMBURKAR.

1. Raistrick, H. and Neil, K. G., *Chem. Ind.*, 1956, 561.
2. Narasimhachari, N. *et al.*, *Can. J. Microbiol.*, 1963, 9, 134.
3. — *et al.*, *Proc. Ind. Acad. Sci.*, 1965, 61 B, 160.
4. — *et al.*, *Experientia*, 1965, 21, 376.
5. Cooke, R. G. *et al.*, *Austral. J. Chem.*, 1958, 11, 230.
6. Loudon, J. D. and Razdan, R. K., *J.C.S.*, 1954, 4,300.

ANTICHOLINERGIC ACTION OF  
TESTOSTERONE

RECENTLY testosterone has been shown to possess a non-specific and non-competitive anti-acetylcholine action on smooth muscle (Hava and Helfert, 1967). Testosterone has been shown to possess significant action on acetylcholine metabolism in experimental animals. Torda and Wolff (1950) demonstrated testosterone to depress the cholineacetylase activity of minced frog brain, *in vitro*. Everett and Sawyer (1946) showed castration to increase and testosterone to decrease the cholinesterase content of blood of male rats. Watten wyl *et al.* (1943) however observed castration to decrease and testosterone to increase the cholinesterase content of blood of guinea-pigs.

Little is known about the effect of testosterone on the action of acetylcholine on cardiac muscle. In the present communication a study was made of the *in vitro* effect of testosterone on the action of acetylcholine on frog heart. Perfusion of isolated frog heart (Burn, 1952) was done with 1% ethanol ringer. Testosterone was dissolved in ethanol (1 mg./ml.) and this solution was added to ringer solution. The final dilution of testosterone was 1 mg./litre of ethanol ringer. The effect of acetylcholine, adrenaline and K ions

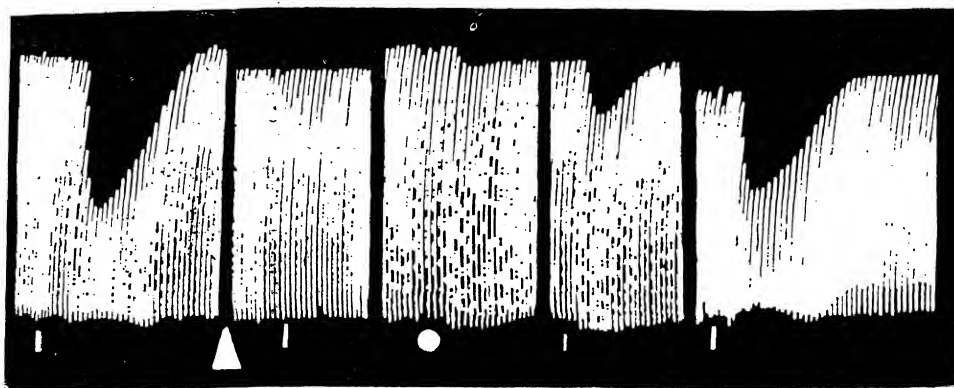


FIG. 1. At ▲ perfusion of testosterone containing ethanol ringer was started and at ● perfusion with normal ethanol ringer was started. Acetylcholine ( $1 \mu\text{g.}$ ) was given at I.

was studied, before, during and after perfusion with testosterone ringer solution.

As shown in Figure 1, testosterone completely blocked the action of acetylcholine but did not modify the responses to adrenaline or potassium ions. This concentration ( $1 \text{ mg./litre}$ ) of testosterone did not possess any significant action of its own on the frog heart. Thus it is evident that this inhibition of acetylcholine action is specific and reversible as the responses to acetylcholine return to normal after testosterone perfusion is stopped. Higher than  $1 \text{ mg./litre}$  of testosterone was found to cause decrease in the force and rate of contraction of frog heart which was proportional to the concentration of testosterone.

Castration has been shown to cause slowing of pulse in man (Hamilton, 1948). It does not seem unlikely that the anticholinergic action of testosterone, which has been observed in the present study, might be concerned with the above phenomenon.

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Indore, M.P., December 14, 1967.

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1. Hava, M. and Helfert, I., *Arch. Int. Pharmacodyn.*, 1967, **166**, 79.
2. Torda, C. and Wolff, H. G., *Amer. J. Physiol.*, 1950, **161**, 180.
3. Everett and Sawyer, *Endocrinology*, 1946, **39**, 323.
4. Watten wyl, H. V., Bessiger, A., Martiz, A. and Zeller, *Helv. Chim. Acta*, 1943, **26**, 2063.
5. Hamilton, J. B. (Brooklyn), *Recent Progress in Hormone Research*, 1948, **3**, 257.

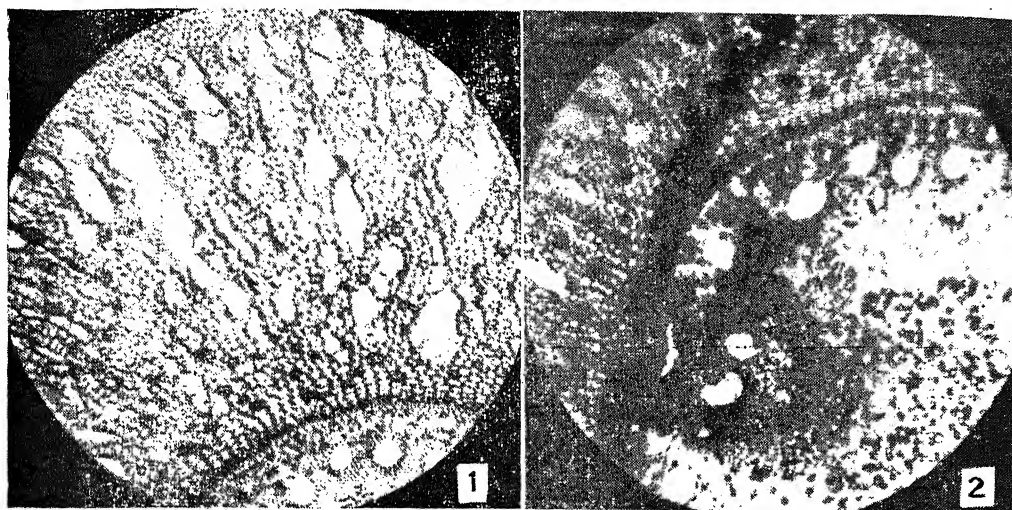
#### A NOTE ON THE ANATOMICAL DERANGEMENT IN THE ROOT TISSUE OF ROOT (WILT) DISEASED COCONUT PALM

VISIBLE root decay has been associated as a symptom of root (wilt) disease of coconut palm, the etiology of which has been the subject of investigations in the recent past. A virus or similar pathogen has been described as a primary causal factor, while soil factors, fungal infection of roots, etc., have been described as secondary factors.<sup>1,2</sup> Wilt being the predominant symptom of this disease, visible root decay found associated with the disease is noteworthy. The present note deals with a study of the internal structure of roots of diseased palms, which did not show any sign of root decay externally.

Root portions cut from the tips of actively growing roots of 10 apparently healthy and 10 diseased palms growing in diseased soil as well as roots of healthy palms were studied. Root-tips showing signs of decay externally were excluded. Thin longitudinal and transverse sections obtained from the above root tissues were studied under the microscope after proper staining wherever necessary. Data on the microscopic examination of over 200 root portions were recorded.

Internal browning of vascular elements extending into the cortex and sometimes accompanied by disintegration of vascular elements also were observed in 60% of the roots of diseased palms examined (Fig. 2), while mild internal browning of tissues was observed in 33% of the roots of apparently healthy palms





FIGS. 1-2. Fig. 1. T.S. of a root of healthy palm. Fig. 2. T.S. of root of diseased palm—Note the browning of tissues extending into the cortex and disintegration of vascular elements.

growing in diseased soil. Development of tyloses was also noted in the vessels of majority of roots of diseased palms examined. None of the above derangements were observed in the root tissue of healthy palms examined (Fig. 1). It is interesting to note that derangements in the vascular tissue of roots were observed only in the case of palms, whether apparently healthy or diseased, growing in the diseased soil.

Grateful thanks are due to Dr. S. B. Lal, Director, for his encouragement.

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Kayangulam, Kerala (India), A. RAMADASAN.  
February 22, 1968.

1. Menon, K. P. V., *Proc. of the First Meeting of FAO Technical Working Party on Coconut Production, Protection and Processing*. FAO, Bangkok, Thailand, 1963, p. 58.
2. Lal, S. B., *Proc. of the Second Meeting of FAO Technical Working Party on Coconut Production, Protection and Processing*. FAO, Bangkok, Thailand, 1966, p. 273.

#### A QUICK METHOD FOR THE DETERMINATION OF LEAD IN ITS ORES

In the course of analysis of a large number of samples of lead ores, we have developed a method for the determination of lead in ores which does not require a preliminary separation and which is rapid and accurate. The procedure is as follows:

Weigh 0.5-2 g. of the finely powered ore into a 250 ml. beaker. Add 20 ml. of hydrochloric acid, cover and boil for 10 minutes. Cool, add 5 ml. of nitric acid and heat gently till the reaction is complete. Evaporate on a low heat to almost dryness, cool, add 20 ml. of 1:1 hydrochloric acid, boil for 5 minutes, and evaporate on a low heat to near dryness. The quantity of acid left should not exceed 0.5 ml. Digest with 25 ml. of distilled water. Cool and neutralise with a saturated solution of sodium carbonate. Acidify with acetic acid and add 3 ml. in excess. Add 20 ml. of a saturated solution of ammonium acetate and stir well. Add 0.5 g. ammonium sulphate to precipitate any barium present and again stir well. Add 15 ml. of a saturated solution of potassium dichromate, stir well and dilute to 150 ml. Keep overnight to ensure the complete precipitation of the lead. Filter, wash the precipitate with a 2% solution of acetic acid containing 1% ammonium acetate. Dissolve the precipitate of lead chromate in 20 ml. of 1:1 hydrochloric acid, add 5 ml. of 1:1 sulphuric acid, 3 ml. of phosphoric acid and measured excess of standard ferrous ammonium sulphate solution. Dilute to 200 ml. Add 4 drops of 0.1% potassium diphenyl amine sulphate solution and titrate at once with standard potassium dichromate solution to a blue-violet end point. Following are some of the typical results obtained.

A slightly modified procedure which is faster can also be used if the quantities of lead present

TABLE I

Sl. No.	Lead found by the <sup>1</sup> classical method (%)	Lead found by the new method (%)
1	44.22	44.55
2	33.13	33.27
3	19.25	19.50
4	12.35	12.18
5	11.30	11.48
6	8.87	8.98
7	6.41	6.30
8	3.38	3.32
9	1.89	2.03
10	0.63	0.58
11	0.18	0.21
12	0.07	0.07

are not very low. This involves the precipitation of the lead (in the cold) with a measured excess of standard dichromate solution, making up the volume to 250 ml., keeping overnight, decanting through a dry filter-paper and determining the excess dichromate with ferrous sulphate. The precipitation of lead with the excess dichromate can also be effected in hot solution and the liquid decanted after keeping for two hours instead of overnight.

The authors are grateful to Dr. A. N. Chowdhury, Superintending Chemist, Sri. M. S. Balasundaram Director and Sri. G. C. Chatterji, Director-General of the Geological Survey of India, for their kind interest and encouragement and for permission to publish this paper.

Chemical Laboratory, C. R. VISWANADHAM.  
Southern Regional Office, R. G. JOSHI.  
Geol. Survey of India, S. B. AKOLKAR,  
Hyderabad, M. RAVINDRAN NAYAR.  
November 11, 1967. S. R. MUKUNDA RAO.

1. Kolthoff I. M. and Elving, P. J. (Ed.), *Treatise on Analytical Chemistry*, Interscience Publishers, New York and London, 1964, 6, Part 2, 110.

### SOME STORAGE DISEASES OF FRUITS

DURING the survey of storage diseases of fruits and vegetables, undertaken by the authors since 1962, a number of diseases were observed, of which many were previously not described from India. The present note describes three such diseases:

1. *Anthraco*se of *Averrhoa carambola* L.—In the initial stages light brown shallow pits appear on the ribbed margin of the fruits. Later they enlarge and many of them coalesce. Subsequently, salmon coloured masses of spores oozing from the acervuli make their appearance on such lesions.

The disease is caused by *Colletotrichum gloeosporioides* Penz. Pathogenicity test indicated that every fruit got infected when the fungus was inoculated after inflicting even slightest injury to the fruits, but only 30% infection was observed on unwounded fruits.

2. *Aspergillus* Rot of *Spondias mangifera* Willd.—Initially the disease appears as water-soaked lesion which later becomes dull light brown in colour. It gradually enlarges and gets depressed. In advanced stages black conical heads appear on the infected tissue.

The disease is incited by *Aspergillus niger* van Tiegham. Injury has been found prerequisite for initiation and development of the infection.

3. *Scab* of *Pisum sativum* L.—Scab like spots appear on the surface of the pods, which are usually dark brown or black, irregular in shape and slightly raised. Inside wall beneath the scab lesions frequently shows white felty or hair-like proliferations.

Scab is brought about by *Cladosporium sphaerospermum* Penzig. The fungus on inoculation to pea pods produced typical symptoms characteristics of scab. A similar type of scab is, however, known to be incited by *C. pisicolum* Snyderl in the United States of America.

The authors are grateful to Dr. J. C. F. Hopkins, ex-Director, Commonwealth Mycological Institute, Kew, Surrey, England for confirming the specific identity of the scab and anthracnose fungi.

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1. Snyder, W. C., "A leaf, stem and pod spot of pea caused by a species of *Cladosporium*," *Phytopath*, 1954, 24, 890.

### A ROOT ROT OF GRAPES IN ANDHRA PRADESH

In recent years, with the intensive cultivation, the grape grower is facing with several pest, disease and agronomic problems.

In the last 2 or 3 years, death of mature vines of *Anab-i-Shahi* and Selection 7 has been observed in several vineyards in and around Hyderabad. Single vines, occasionally contiguous ones are also affected. The onset of the disease is insidious. The leaves turn chlorotic, the vines become moribund. The

symptoms generally appear following the monsoon rains. The pruned vines either fail to recover or having recovered partially die-back. The roots and collar of the affected vines, in a few instances, had some evidence of ecto-parasitic nematodes, but in most cases, there was typical decomposition of the bark and cortical cells brought about by fungi. On several specimens examined in the laboratory, *Phytophthora cinnamomi* Rands was invariably present although occasionally the following fungi were also noticed. Two *Fusarium* spp., each belonging to *elegans* and *martiella* sections, an undetermined species of *Rosellinia*, *Melanospora brevirostrata* Moreau, *Diplodia natalensis* Desm., *Neocosmospora vasinfecta* E.F.S. *Pythium aphanidermatum* (Eds.) Fitzp. and an undetermined species of *Phytophthora*. A brief description of *Phytophthora cinnamomi* from a composite collection is given below:

**PHYTOPHTHORA CINNAMOMI RANDS** in  
*Meded. Inst. PlZiekt., Buitenzorg.*, 54, p. 41,  
1922.

Mycelium intra and intercellular in cortical and bark tissues, sparingly anastomosing, upto  $6\mu$  in width. Chlamydospores present, generally globose upto  $50\mu$  in diameter, often occurring in clusters. Conidiophores undifferentiated, sympodially branched. In nature, the sporangia were observed very rarely on incubated material but in mycelial transfers on to sterile distilled water or nutritional solutions, abundant sporangial production was noticed. These are terminal, ellipsoid with an inconspicuous papilla, measuring  $30-60$  ( $-85$ )  $\times$   $25-33$  ( $-40$ )  $\mu$ . Secondary sporangia were observed by proliferation through the empty ones. Biflagellate, reniform, zoospores were observed measuring  $10 \times 16\mu$ , oospores were not observed in any of the specimens collected.

There are very few records in the literature of *Phytophthora* spp. associated with diseases of vines.<sup>1</sup> Chiarappa<sup>2</sup> found that 32% of the fungi isolated from the rhizosphere and roots of grape vines in the San Joaquin Valley of California were various species of *Phytophthora*. Recently McGeachan<sup>3</sup> isolated *Phytophthora cinnamomi* from the roots of vines resistant to *Phylloxera* in Australia.

In view of the fact that *Phytophthora cinnamomi* has been recorded in relation to root rots of several ornamental and fruit crops from all over the world, it is imperative that further investigations are carried out on the

pathogenecity, biology and control of the fungi in vineyards.

In early stages of attack, the ill-effects of the fungus can be overcome temporarily by heaping up of the soil at the collar which encourages new root growth. A certain degree of temporary relief was observed by treating the soil with fixed coppers and Cheshunt compound, Bordeaux mixture, etc. As it is very likely that the fungus is a soil inhabitant it should be noted that thorough soil sanitation measures may be necessary before infilling the vacancies.

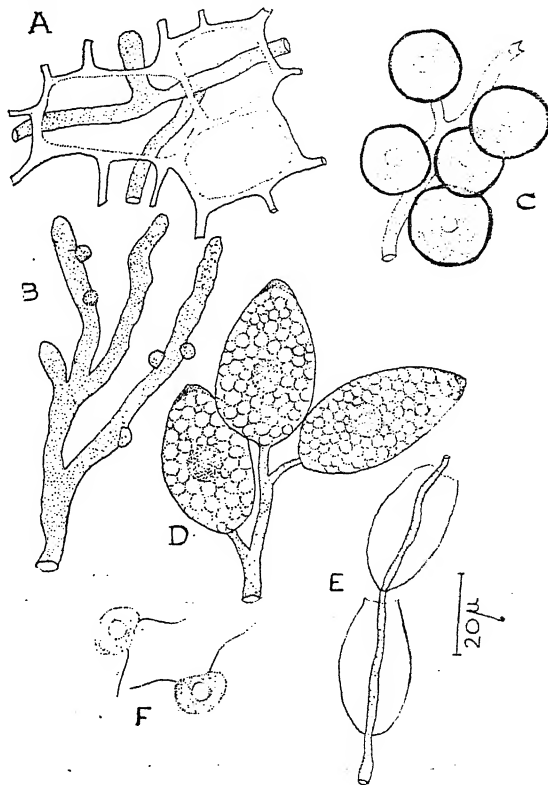


FIG. 1. *Phytophthora cinnamomi* Rands. A, Intra-cellular mycelium of the fungus in bark cells; B, Mycelium from nutrient cultures; C, Chlamydospores; D, Sporangia; E, Proliferating sporangia after they have emptied the spore contents. F, Biflagellate zoospores.

A survey of the role of several cultural practices in relation to the incidence of the disease, particularly water management and the extent to which the disease, is responsible for any decline in yields should be immediately investigated.

The author is grateful to several grape garden owners for liberally supplying the material for investigations, to Rallis India

Limited, for permission to publish this note, to Mr. V. R. Rajagopalan and Mr. R. Sata-gopan for arranging visits to vineyards and Mr. Srinivasa for taking him round the vineyards.

Rallis India Limited, V. AGNIHOTHRUDU.  
Fertilisers and Pesticides Div.,  
P.O. Box No. 68,  
Bangalore-1, March 4, 1968.

1. Millikan, C. R., *J. Agric. Vict.*, 1950, 48, 676.
2. Chiarappa, L., *Phytopathology*, 1959, 49, 670.
3. McGechan, J. K., *Australian J. Sc.*, 1966, 28, 354.

### OCCURRENCE OF PLASTID MUTATION AND ITS INHERITANCE IN *GOSSYPIUM*

VARIATION or plastid abnormalities have been reported in many plants like maize,<sup>1</sup> tobacco,<sup>2</sup> *Primula*<sup>3</sup> and wheat.<sup>4,5</sup> A reference to the Texas Experimental Station report<sup>6</sup> shows that variegated plants have been observed in tetraploid cotton species, *Gossypium hirsutum* and *G. barbadense*. Recently Kohel<sup>7</sup> reported in detail the inheritance of variegation in *G. hirsutum*.

In the present study, a variegated plant was isolated from a small population of Russian *hirsutum* (var. PRS-72) grown for the first time in Delhi in 1965. The leaves of this plant were of four types, viz., (1) white, (2) yellow, (3) green and yellow mosaic, and (4) normal green (Fig. 1). Three bolls were collected from the selfed plant. Two of the three bolls were white or variegated and the third was normal green. Seeds from these bolls were sown separately and the seedlings were screened.

All the seedlings derived from the green boll were normal. The seedlings derived from the variegated and white bolls fell under three categories, viz., yellow, variegated and green. To start with all seedlings looked similar but when unfolding of the cotyledons was completed, it was possible to differentiate normal and variegated seedlings. The yellow seedlings died three days after their emergence under field conditions and after five days in pots. The variegated seedlings had low survival in the field but when grown in pots their survival was improved.

In order to study the nature of inheritance of this plastid mutation, reciprocal crosses were made using the variegated plants and two other strains, C-1998 and H-14. Flowers selected from sectors which were showing



FIG. 1

chlorophyll abnormality were used in all crossings. The results are given in Table I.

TABLE I

Female	Male	F <sub>1</sub>	F <sub>2</sub>
PRS-72	Variegated	Green, yellow, variegated	..
C-1998	× C-1998	Green	Green
	× PRS-72	variegated	
PRS-72	× H-14	Green, yellow, variegated	..
H-14	× PRS-72	Green	..
	variegated		

The F<sub>1</sub> and F<sub>2</sub> data clearly show that the inheritance of variegation is only through the female side and nuclear factors are not involved. It is now well known that DNA is present in plastids<sup>8</sup> and it is possible to visualise its mutation which will alter the structure and function of the plastid. This, when transmitted through the maternal side, gives the offspring the yellow or variegated phenotype, depending on the inclusion of normal proplastids. The inheritance studies made by Kohel<sup>7</sup> also led to similar conclusion. The lethal seedlings were scored as *albino* by Kohel but in the present study, it was observed that they were yellow in colour due to the unmasking of carotenoid pigments. Hence it is suggested

that the word *xantha* may be a more appropriate description of such lethal seedlings.

I am grateful to Dr. H. K. Jain, Head, Division of Genetics, for providing the necessary facilities.

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1. Anderson, E. G., *Bot. Gaz.*, 1923, **76**, 411.
2. Burk, L. G. and Grosso, J. J., *J. Heredity*, 1963, **54**, 23.
3. Gregory, R. P., *J. Genet.*, 1915, **4**, 305.
4. Pao, W. K. and Li, H. W., *J. Am. Soc. Agron.*, 1946, **38**, 90.
5. Briggie, L. W., *Crop Sci.*, 1966, **6**, 43.
6. Harland, S. C., *The Genetics of Cotton*, London, 1939, p. 1.
7. Kohel, R. J., *Crop Sci.*, 1967, **7**, 490.
8. Gibor, A. and Granick, S., *Science*, 1964, **145**, 890.

#### OBSERVATIONS ON DEGREE OF APOSPORY IN THREE MEMBERS OF ANDROPOGONEAE

IN most of the agamic complexes in grasses and particularly in *Andropogoneae*, diploids are sexual, tetraploids are facultative apomicts while pentaploids and hexaploids are obligate apomicts with some exceptions. For studies of apomixis in this tribe, essentially two different methods have been used in the past: (1) Hybridization between apomicts and sexual plants, taking maternal inheritance as a proof of apomixis, and (2) Embryological methods using microtome sections or smear techniques.

In the present study, apomixis in three tetraploid members of *Andropogoneae*: namely *Bothriochloa pertusa* (L.) A. Camus, *Dichanthium annulatum* (Forssk.) Stapf, and *Heteropogon contortus* (L.) Beauv., was studied using embryological methods. All these three grasses are excellent fodder grasses and therefore apomixis can be economically exploited. Flowering material at different stages of development was killed and fixed in navaschin. Ovaries were sectioned at 8-12  $\mu$  and stained in safranin fast green combination.

In the three materials studied, the development of the female gametophyte followed two distinctly different patterns, one of them resulting in 8-nucleate sexual embryo-sac and the other resulting in 4-nucleate aposporic embryo-sac.

**Sexual Embryo-Sac.**—The megaspore mother cell divided by meiotic division and gave rise to a linear quartet (Figs. 1, 2), of which only chalazal megaspore was functional (Fig. 3). The functional megaspore nucleus divided by a mitotic division and the resulting two nuclei separated to two poles (Fig. 4). Each of these nuclei divided by two successive divisions, giving rise to an 8-nucleate embryo-sac with three antipodals, two polars, one egg and two synergids. The antipodals further divided by many divisions (Fig. 5). In *Heteropogon contortus* the development of sexual sac did not proceed beyond meiosis and therefore no mature sexual embryo-sacs were observed in this species.

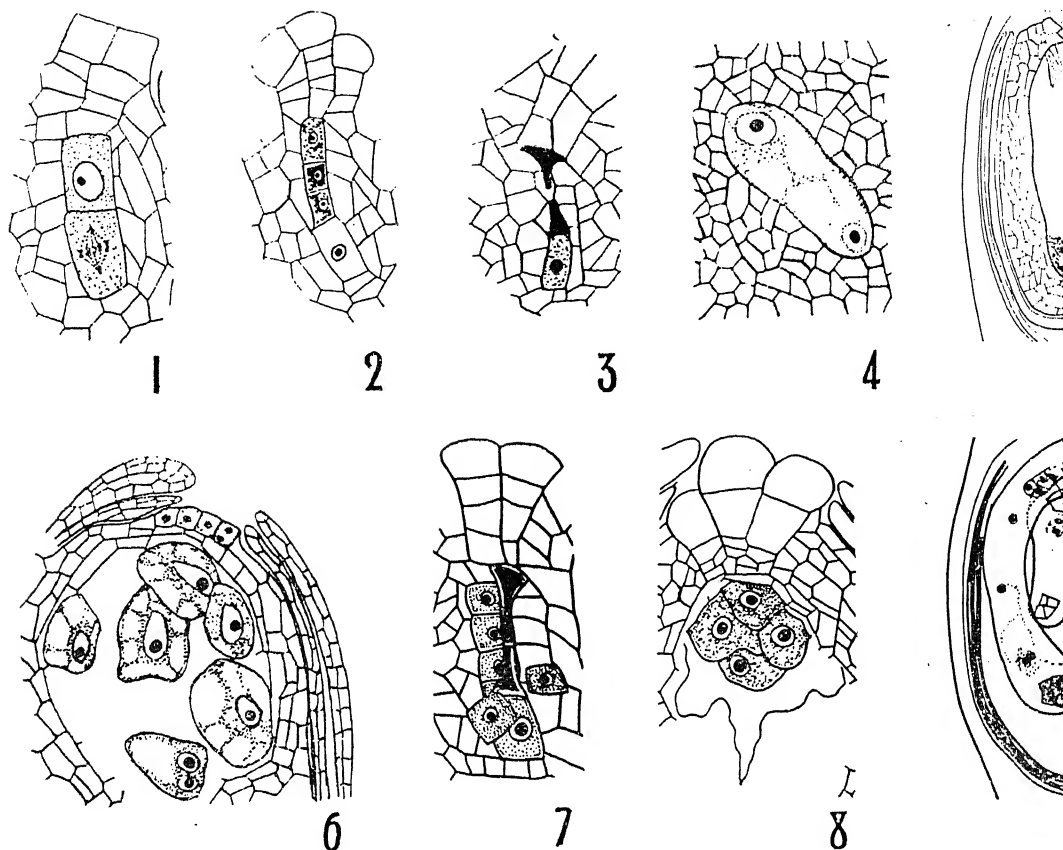
**Aposporic Embryo-Sac.**—One or more nucellar cells enlarged and functioned as aposporic embryo-sac initials (Figs. 6, 7). The nucleus which remained restricted to one pole by a big vacuole, divided twice and the resulting four nuclei differentiated into two synergids, one egg and one polar (Fig. 8). Aposporic sac or sacs were found accompanied more regularly by a single, but rarely by two, sexual sacs (Fig. 9) in the same ovule.

The frequency of aposporic and sexual embryo-sacs is given in Table I. It is evident that the relative frequency of the two types of embryo-sacs differed in the three species.

TABLE I  
Frequency of aposporic and sexual embryo-sacs in three species

Species	Aposporic embryo-sacs	Sexual embryo-sacs	Total
(1) <i>Bothriochloa pertusa</i>	22 (36.1%)	39 (63.9%)	61
(2) <i>Dichanthium annulatum</i>	157 (67.1%)	77 (32.9%)	234
(3) <i>Heteropogon contortus</i>	203 (100%)	..	203

Measured in terms of univalents, multivalents, laggards, bridges and fragments, the results for which will be published elsewhere, the three materials used showed different degrees of meiotic irregularities. Meiosis in *B. pertusa* was least abnormal, while in *H. contortus* it was highly disturbed. The condition in *D. annulatum* was, however, intermediate. When these results are compared with those presented in Table I, a correlation between the relative frequency of aposporic embryo-sacs and the degree of meiotic irregularities is obvious.



FIGS. 1-9. Figs. 1-5, 9. *Bothriochloa pertusa*; Fig. 6. *Heteropogon contortus*; Figs. 7, 8. *Indium annulatum*. Figs. 1-3. Formation of linear quartet. Fig. 4. 2-nucleate sexual sac. Fig. 5. M sexual embryo-sac. Fig. 6. Many aposporic initials, one with 2 nuclei at one pole. Fig. 7. 2 overlapping quartets with 2 aposporic initials. Fig. 8. Mature aposporic embryo-sac. Fig. 9. 2 sexual embryo-sacs and 1 aposporic embryo-sac in the same ovule. (Figs. 1-4, 6-8,  $\times 500$ ; Figs. 5, 9,  $\times 300$ ).

The three species selected for the present study belonged to the sub-tribe *Andropogoninae* of the tribe *Andropogoneae* and were related to each other as evident from base chromosome number ( $x=10$ ), spike morphology and spikelets arrangement, etc. On the basis of recorded introgression Harlan *et al.* even suggested that *Dichanthium*, *Bothriochloa* and *Capillipedium* should be lumped together as one genus. It is natural therefore to expect that apomixis followed the same evolutionary path in these three species. As evident from the degree of apospory recorded in the present study, the three materials represented three stages of evolution of apomixis. The material of *H. contortus* represented the last stage, while that of *B. pertusa* represented a very early stage of such an evolution. However, the degree of apospory recorded in the three materials was not characteristic of the respec-

tive species, and one could expect to find different stages in the same species in material collected from different geographical areas. A species thus becomes more and more spermatophorous, as the number of unreduced embryo-sacs increases and as the haploid (pollen, embryo-sacs or egg cells) becomes lethal.

The author wishes to express his thanks to Prof. R. P. Roy, who initially suggested the problem and to Prof. K. S. Bhargava for providing the facilities.

Department of Botany, P. K. S. Bhargava  
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Gorakhpur, U.P., December 18, 1967.

1. Harlan, J. R., de Wet, J. M. J., Richards and Chheda, H. R., *Okla. Agr. Exp. Bul.*, T-92, October 1961, p. 5.

# SUCROSE PENETRATION IN OSMO-FREEZE DEHYDRATED APPLE SLICES

THE osmotic effect of sucrose has been reported to have some advantages in producing the osmo-freeze dehydrated fruits.<sup>1</sup> The investigation reported here was designed to explain the effect of sucrose on dehydration. The osmotic process and the penetration of sucrose by diffusion were studied during the pretreatment of freeze dehydrated fruit.

A fresh apple slice (1 × 1 × 4 cm.) was placed in 50 ml. of 0.7, 1.5, 2.0 Molar (M) sucrose solutions and in dry sucrose. The changes in weight and in soluble solids due to sucrose diffusion and moisture transfer between each solution and fruit slices were determined after 5, 10, 15 and 20 hours at room temperature (22°-24° C.). C<sup>14</sup> labelled sucrose (10 μc for each 50 ml. sucrose solution) was also employed along with normal sucrose. Immersed apple slices were frozen at -50° C. for 20 minutes and then subjected to freeze dehydration as reported previously.<sup>1</sup> Thin sections were made from the dehydrated apple slices for autoradiographs. A layer, approximately 1 mm. thick, was sectioned from each surface of the dehydrated slices. Moving inward, second, third, and fourth layers were sectioned. Each layer was analyzed for its soluble solids content.

The slices that were immersed in 0.7 M sucrose solution showed no noticeable change in weight, because the osmotic pressure of the solution was close to the diffusion pressure deficit of the apple fruit. As the sucrose concentration of the impregnating solution increased, the percentage weight loss of the slice tended to increase. This progressive variation is the result of osmotic effects, i.e., by more fluid moves from the slice to the more concentrated sucrose solution. The slices in dry sucrose showed the maximum weight loss (about 40%) among the treatments after 20 hours. In this case the deliquescent property of sucrose, in addition to its high osmotic effect, may be involved in the change of fruit weight.

Soluble solids in fruit slices increased as the sucrose content of the solution increased. This tendency was proportional to the immersion time. The slices immersed in 2.0 M sucrose solution showed considerable increase in soluble solids content whereas those in the 0.7 M solution underwent only a slight increase. The apple slices placed in dry sucrose were lower in soluble solids than were

the slices from the 1.5 and 2.0 M sucrose solutions. This was probably due to the absence of solvent (H<sub>2</sub>O) and/or the saturated concentration which may decrease the molecular movement of sucrose and subsequently reduce the rate of the sucrose penetration into the fruit slices. The movement of the fluid from the apple slices into the solution probably was due to osmotic pressure differences across the imperfect semipermeable membranes of the apple cells. The concentration gradient might be distorted to a certain degree due to volume (or weight) changes in the apple slices.

It has been reported that in peaches a high concentration gradient of sucrose causes an initially rapid movement of sucrose into the flesh of the peach despite the rapid movement of fluid from the fruit.<sup>2</sup> Hughes and others explained that the flow of fluid under the osmotic pressure gradient very likely continued until the activity of water was equal in the syrup and the peach slices during the processing. The equilibrium condition was not attained in the apple slice study. It seems reasonable to assume, however, that the diffusion of sucrose and fluid probably would continue until the gradients became equal within the apple slices and the solution.

Autoradiographs for each apple slice immersed in each concentration of C<sup>14</sup> labelled sucrose solutions indicated the degree of radioactivity on the surface area of slices was proportional to the concentration of sucrose. However, no conspicuous differences in depth of sucrose diffusion into fruit tissue were noticed. Soluble solids analyses at different depths of apple slices from each concentration of sucrose indicated considerable sucrose in the outermost layer with all treatments. No appreciable differences occurred in sucrose contents in the second, third and fourth layers. These findings corroborated the results derived from the autoradiographic study.

It may be concluded that most of the sucrose from the test solutions remained within the surface layers of the apple slices.

Food Science and

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March 21, 1968.

1. Lee, C. Y., Salunkhe, D. K. and Nury, F. S., *J. Sci. Ed. Agric.*, 1967, **18**, 89.
2. Hughes, R. E., Jr., Chichester, C. O. and Sterling, C., *Food Technol.*, 1958, **12**, 111.



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## REVIEWS AND NOTICES OF BOOKS

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**Early Nineteenth Century European Scientists.**

Edited by R. C. Olby. (Pergamon Press), 1967. Pp. xi + 179. Price 27 sh. 6 d.

The early nineteenth century saw exciting developments in many fields of science. Here five topics are reviewed in the context of seven biographies—chemistry under Humphry Davy and Berzelius, optics under Thomas Young, photography under Daguerre and Fox Talbot, geology under Lyell and statistics under Quetelet.

The contents are: Introduction, by R. C. Olby; Sir Humphry Davy, 1778–1829, by D. Knight; Jons Jacob Berzelius, 1779–1848, by D. M. Dallas; Thomas Young, 1773–1829, by J. R. Levene; Louis Jacques Mande Daguerre, 1789–1851 and William Henry Fox Talbot, 1800–77, by P. R. Norman; Sir Charles Lyell, 1797–1875, by J. P. Bolam; Adolphe Quetelet, 1796–1874, by G. M. Jolly and P. Dagnelie. C. V. R.

**Recent Advances in Biological Psychiatry**

(Vol. IX). Edited by Joseph Wortis. (Plenum Press, New York), 1967. Pp. xii + 377. Price \$ 6.50.

This volume represents the Proceedings of the Twenty-First Annual Convention and Scientific Program of the Society of Biological Psychiatry, Washington, D.C., June 10–12, 1966.

The subject-matter in this volume has been dealt with in seven parts as listed below: Part I: Presidential Address; Part II: Genetic Determinants of Behavior; Part III: Clinical Research Reports; Part IV: Studies on LSD; Part V: Laboratory Research Reports; Part VI: Developmental Studies; and Part VII: A. E. Bennett Award Papers. C. V. R.

**Berkeley Physics Course. Volume 3—*Waves and Oscillations*.** By Frank S. Crawford, Jr. **Volume 4—*Quantum Physics*.** By Eyvind H. Wichmann. (McGraw-Hill Book Co.).

The three volumes 1, 2 and 5 of this Course which had come out earlier were reviewed in these columns. The present two volumes, which complete the set, are the preliminary editions in typed mimeography. As mentioned in the earlier review, the course is intended to provide a guide to upgrade the teaching of

physics at lower levels in colleges so that the student acquires sufficient background knowledge to receive advanced instructions in modern developments of physics, at graduate and post-graduate levels.

The volume on *Waves and Oscillations* covers the subject in the following five chapters; each of about 60 pages: (1) Modes, (2) Waves, (3) Emission and Absorption of Waves: Impedance, (4) Polarization, (5) Interference and Diffraction. Each chapter contains problems and home experiments. In addition there is a mathematical appendix and a section of advanced topics.

The volume on *Quantum Physics*, also of about 500 pages, aims at introducing beginning students to quantum mechanical thinking. The text material deals with the following topics: Magnitudes of physical quantities in quantum physics; Energy levels and their theory; Photons; Material particles; Quantum mechanical theory of measurements; Phenomenological wave mechanics of Schrodinger; Problem of describing interactions.

A. S. G.

**Electron Spin Resonance Spectrometers.** By T. H. Wilmshurst. (Adam Hilger Ltd., 98, St. Pancras Way, London N.W. 1), 1968. Pp. 280. Price 70 sh.

Hilgers Monographs as a rule, are highly useful and practical. The present publication is no exception; it is a definitive addition to the literature on the subject. Although ESR spectroscopy has come into use in many fields of research there has remained a need for a book of this kind to give the users of this technique that clear understanding of the principles involved and the design of the instruments which they are handling. The monograph covers all aspects of ESR instrumentation from the simplest to the most complex spectrometer designs. The chapter on the design of ESR cavities, and the concluding chapter on Electronic Circuitry in which the author gives a stage-by-stage description of a modern ESR spectrometer which he himself has designed, built and tested, will be highly useful to working physicists and engineers.

A. S. G.



**Language, Logic and Mathematics.** By C. W. Kilmister. (The English Universities Press, Limited, St. Paul's House, Warkick Lane, London E.C. 4). Pp. 124. Price 25 sh. net in U.K.

This is a publication of the New Science Series under the General Editorship of Sir Graham Sutton. The aim of the Series is to provide authoritative accounts of topics chosen from the wide range of modern science. The books have been written to appeal to intelligent readers who are willing to make conscious effort to understand the thoughts and achievements of specialists in various branches of science physical, biological, social, etc.

In the present century, studies which have been made in the foundations of mathematics have been couched in language too technical to be appreciated by other than the mathematicians themselves. The present book attempts to explain just enough mathematics in simple terms to aid understanding of the modern developments in the foundations, logic and language of mathematics. The topics discussed include Boole's Logic, Cantor's Set Theory, The Logic of Whitehead and Russell, The Decision Problem and Church's System, Hilbert's Metamathematics, Gödel Numbers, Turing's Computing Machines. A. S. G.

**Harvesting the Sun (Photosynthesis in Plant Life).** Edited by Anthony San. Pietro, Frances A. Greer and Thomas J. Army. (Academic Press, Inc., 111, Fifth Avenue, New York), 1967. Pp. 342. Price \$7.50. or 60 sh.

The International Minerals and Chemical Corporation, Chicago, Illinois, sponsored a symposium on October 5-7, 1966 to commemorate the opening of its new Growth Science Centre, Libertyville, Illinois. The subject of the symposium was Photosynthesis in Plant Life. The publication contains the papers presented at the symposium.

In essential, photosynthesis is the natural basic process of converting solar radiation energy—the electromagnetic energy in the visible region—to chemical energy in a form useful for life. The papers discuss the process in all its various aspects from the photoactivation of molecules to the growth of the plant in the field. Thus they cover Biochemical aspects of photosynthesis, Carbon metabolism, Chloroplast structure and Genetics, Water and CO<sub>2</sub> transport, Aerodynamic studies of carbon dioxide change between the atmosphere and

the plant, Photosynthetic limits on crop yields, etc. A. S. G.

**An Introduction to Abstract Mathematical Systems.** By D. M. Burton. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W. 1), Pp. 120. Price 25 sh.

The book is an outcome of a series of lectures given by the author in a summer institute of high school teachers of mathematics. It explains and develops the main systems of abstract algebra, viz., Groups, Rings, Fields, and Vector Spaces. A first chapter on sets and functions provides background knowledge to the development of the topics mentioned above. The book will serve as a useful guide to teachers of modern algebra in schools and colleges. Numerous exercises of varying degrees of difficulty are included at the end of each chapter. A. S. G.

**Guide to Gas Chromatography Literature** (Vols. 1 and 2). By Austin V. Signeur. (Published by Plenum Press, New York), Pp. 351 and 379. Price \$15.00 each.

The two volumes contain the bibliography of papers on Gas Chromatography that have been published from the beginnings of this technique to 1967. Volume I contains 7577 references up to mid-1963, and Volume II as many as 7989 taking the literature to 1967. Papers are arranged alphabetically according to the name of the first author. References give the names of the authors, Title of the paper, Journal of publication, and pagination. Papers presented at Symposia and Scientific Meetings have also been included. There is a classified subject index at the end of each volume to facilitate easy reference to topic of special interest by the user. A. S. G.

**Introductory Relativity.** By W. G. V. Rosser. (Butterworth and Co., Publishers, Ltd., 88, Kingsway, London, W.C. 2), 1967. Pp. 347. Price 36 sh.

This book has been designed as a text-book on Relativity for undergraduate students of Physics, Engineering and Mathematics. The first two chapters of a historical nature explain Newtonian Mechanics and take the student straight to the theory of Special Relativity. Then comes the Lorentz Transformations which are treated both in the conventional manner and by Bondi's method of

the K-calculus. The latter treatment, which is based on the Radar method for measuring positions and times of events, is likely to find greater appeal with students. Relativistic Kinematics and Relativistic Mechanics have been treated exhaustively. A section is devoted to Mossbauer Effect. The Clock Paradox is explained in detail, and the final chapter is devoted to the Theory of General Relativity.

This book with its lucid exposition of the fundamentals of Relativity theory and its applications has something more to offer than the usual text-books on the subject. A. S. G.

**Physical Chemistry.** By C. W. Wood and A. K. Holliday. (Butterworth and Co., Ltd., 88, Kingsway, London, W.C. 2), 1967. Pp. 351. Price 25 sh.

This popular Intermediate Text-Book on Physical Chemistry has come out in its Third Edition. The new edition includes fresh material of importance, and also addition to the lists of questions and problems. Besides, some alterations in the sequence of the textual matter have been made with a view to emphasize the topics concerned. A. S. G.

**Directory of Indian Scientific Periodicals.** (Printed and Published by the INSDOC, Hillside Road, Delhi-12), 1968. Pp. 182. Price Rs. 10 or \$ 3.00 or £ 1.

This is the second edition of the Directory, the first edition of which was published in 1964. The new edition lists 996 periodicals as against 725 listed in the first edition. It includes 108 (as against 60) periodicals published in various Indian languages.

A. S. G.

**University of Chicago Graduate Problems in Physics with Solutions.** By J. A. Cronin, D. F. Greenberg and V. L. Telegdi (Addison-Wesley Publishing Co., Inc., 10-15, Chitty Street, London, W. 1). 1967. Pp. 263. Price Hardbound \$ 8.50; Paperbound \$ 4.95.

Postgraduate students working for the Ph.D. degree in physics of the University of Chicago have to pass a qualifying examination known

as "Candidacy Exam," before they are allowed to start on their research program. This comprehensive examination is to test the students' knowledge of the fundamentals of classical and modern physics.

The book under review contains a selection of problems from the papers set for these examinations over the past years. It covers all branches of physics such as mathematical physics, electromagnetism, optics, thermodynamics, statistical physics, atomic physics, electronics, solid state, quantum mechanics and nuclear physics.

The first 68 pages contain the problems divided under 12 sections. The remaining about 200 pages are devoted to the detailed solutions of the problems. The book, if properly used, will be of special value especially to "foreign students" who plan to join American Universities for postgraduate or research studies.

A. S. G.

#### Books Received

*The Invertebrates* (Vol. VI) *Mollusca—I*. By L. H. Hyman. (McGraw-Hill Book Co., 330 W. 42nd Street, New York, 10036), 1967. Pp. vii + 792. Price \$ 17.50.

*New Linear Polymers.* By H. Lee, D. Stoffey, K. Neville. (McGraw-Hill Book Co., New York 10036), 1967. Pp. vii + 374. Price \$ 17.50.

*Scientific Method in Analysis of Sediments.* By J. C. Griffiths. (McGraw-Hill Book Co., N.Y. 10036), 1967. Pp. 508. Price \$ 17.50.

*Berkeley Physics Course No. 3 (Waves and Oscillations).* By F. S. Crawford Jr.; Course 4. *Quantum Physics.* By E. H. Wichmann. (McGraw-Hill Book Co., New York), 1967. Price not given.

*Physical Chemistry—An Intermediate Text.* By C. W. Wood, A. K. Holliday. (Butterworth & Co. Pub. Ltd., London, W.C. 2), 1967. Pp. xi + 351. Price 25 sh.

*Introductory Relativity.* By W. G. V. Rosser. (Butterworth & Co., London W.C. 2), 1967. Pp. xii + 347. Price 36 sh.

*Electron Spin Resonance Spectrometers.* By T. H. Wilmshurst. (Adam Hilger Ltd., London N.W. 1), 1967. Pp. viii + 280. Price 70 sh.

# STEROIDAL AND TRITERPENOIDAL COMPONENTS OF THE LEAVES OF *PUTRANJIVA ROXBURGII*

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*PUTRANJIVA ROXBURGII* (N.O. Euphorbiaceae) is a tree whose leaves and the fruits are used in Indian medicine.<sup>1</sup> Only the seeds have been examined in the past and reported to contain thioglucosides.<sup>2</sup> The leaves have now been examined and a number of triterpenoids and a sterol have been isolated from the benzene extract; four of these are new.

The air-dried leaves (500 g.) collected locally were extracted exhaustively with boiling benzene and the extract after concentration was subjected twice to column chromatography using silica gel. In the first chromatography, elution was carried out with benzene-light petroleum (1:1) followed by benzene alone as long as the material came free of chlorophyll. The product (~15 g.) thus obtained was separated by second chromatography and eluting in small fractions using first light petroleum followed by mixtures of light petroleum and benzene in various proportions, by benzene alone and finally benzene containing 5% acetone. Thus eight distinct fractions were obtained and they are designated A to H in the order of their elution.

*Fraction A* crystallised from alcohol as colourless crystals (0.4 g.), m.p. 65–70°;  $\nu_{\max}$ . 3010(s), 2930(s), 1481(s), 1468(s), 1381(w), 893(w), 730(s) and 719.4(s)  $\text{cm}^{-1}$ ; it seems to be a mixture of aliphatic hydrocarbons.

*Fraction B* ( $\beta$ -Amyrin palmitate) crystallised from ethyl acetate-methanol mixture as small colourless needles (5.0 g.), m.p. 75–76°;  $[\alpha]_D + 67.9^\circ$  (c, 1.06); tlc (solvent A) showed

a single spot; LB reagent gave triterpenoid test and the ir spectrum showed a strong ester carbonyl frequency at  $\nu_{\max}$ . 1748  $\text{cm}^{-1}$ . Since nmr in  $\text{CCl}_4$  showed about 48 methylene protons at  $\delta$  1.25–2.00 ppm and 27 methyl protons at  $\delta$  0.9–1.18 ppm, it was considered an ester of an higher fatty acid with a triterpenoid alcohol. Hence it was boiled with 10% methanolic alkali in benzene medium and an alcohol and an acid were isolated. The alcohol crystallised from chloroform-methanol mixture as colourless needles, m.p. 197–99°  $[\alpha]_D + 85.1^\circ$  (c, 1.01); positive LB and tnm tests. Its acetate crystallised from alcohol as colourless prisms, m.p. 247–48°;  $[\alpha]_D + 76.9^\circ$  (c, 0.86). These properties agreed with those of  $\beta$ -amyrin and its acetate; identification was confirmed by comparison with authentic samples by tlc and ir spectra. The crude acid (m.p. 69°) was converted into its methyl ester with diazomethane which was found to contain only methyl palmitate by glc using polyethylene-glycol adipate as adsorbent and argon as a carrier. Hence fraction B was identified as  $\beta$ -amyrin palmitate<sup>3</sup> (Found: C, 82.9; H, 12.3. Calc. for  $\text{C}_{46}\text{H}_{80}\text{O}_2$ : C, 83.1; H, 12.1%).

*Fraction C* gave a very small amount of viscous liquid which also seems to be an ester of  $\beta$ -amyrin and a higher fatty acid.

*Fraction D* (Methyl putranjivate) gave a colourless solid which was crystallised thrice from methanol yielding colourless prisms (40 mg.), m.p. 133–35°;  $[\alpha]_D - 8.3^\circ$  (c, 1.2)  $\nu_{\max}$ . 1754  $\text{cm}^{-1}$  (ester C=O). Since its mixed melting point was underpressed and ir was superimposable with that of the methyl ester of the new triterpenoid acid named putranjivic acid (described later), it is methyl putranjivate. Occurrence of methyl esters of triterpene acids is rather rare, one recent example being serjanic acid isolated from *Serjania* sp.<sup>4</sup>

*Fraction E* (Putrone, Ia and Putrol, I) yielded a colourless solid (700 mg.) which proved to be a mixture of two compounds having close  $R_f$  values on tlc in solvents B, G and H. Hence it was separated by column

\* Light petroleum had boiling range 60–80°. The solvent systems for analytical tlc (silica gel; spray 10%  $\text{H}_2\text{SO}_4$ ) were: A, light petroleum: benzene (90:10); B, benzene; C, chloroform; D, chloroform: methanol (85:5); E, light petroleum: ethyl acetate (80:20); F, benzene: methanol (100:10); G, light petroleum: ethyl acetate (96:4); H, light petroleum: benzene: chloroform (60:50:10). IR spectra were taken using KBr disc; nmr spectra were recorded in  $\text{CDCl}_3$  (unless otherwise stated) on 60 mc spectrometer using  $\text{Me}_4\text{Si}$  as the internal indicator and the signals are mentioned in ppm;  $[\alpha]_D$  values are recorded at 25° in chloroform solutions, concentration of which are recorded in g./100; m.p.'s were taken on Kofler block.

chromatography using silica gel. The major compound (500 mg.) crystallised from chloroform-methanol mixture as fine silky needles, m.p. 221–22°;  $[\alpha]_D -62.5^\circ$  (c, 1.09); LB reagent gave a pink colour changing to red [Found: C, 84.8; H, 11.8; m.w., 410 (by mass spectrum).  $C_{29}H_{46}O$  requires C, 84.8; H, 11.3%; m.w. 410]. It may be remarked here that this compound tends to retain water of crystallisation and careful drying and analysis have to be done in order to get right results.

Carbonyl frequency at  $\nu_{\max}$ ,  $\text{cm}^{-1}$  in the ir spectrum shows that it may be a 5-membered ring ketone. The keto character is further shown by the ready formation of 2,4-dinitrophenyl hydrazone and oxime. Since such a triterpenoidal ketone is not reported to occur in Nature, it is now called putrone.

Putrone undergoes smooth reduction with sodium borohydride when a mixture of two epimeric alcohols is formed as shown by tlc using solvents B, G and H. The major alcohol separable by column chromatography crystallised from chloroform-methanol mixture as a colourless solid, m.p. 200°;  $[\alpha]_D +17.3^\circ$  (c, 0.82) (Found: C, 80.9; H, 12.1;  $C_{29}H_{48}O$ .  $H_2O$  requires C, 80.9; H, 11.6%). It agrees with the minor component of the natural fraction E isolated by chromatography (yield, 50 mg.) as shown by mmp, comparative tlc and superimposable ir spectra. Since putrone could be obtained from this alcohol by Jones oxidation, this alcohol represents just the reduction of the keto group and is now called putrol. That putrol is a secondary alcohol is confirmed by the proton signal of CH OH in putrol at  $\delta$  4.38 ppm shifting downfield to a quartet centered at  $\delta$  5.42 in putrol acetate which is formed readily with acetic anhydride-pyridine at 100°; it crystallises from ethanol as colourless needles; m.p. 221°,  $[\alpha]_D +17.0^\circ$  (c, 1.71); tlc in solvents B, G and H, showed a single spot and the ir spectrum showed an ester carbonyl frequency at  $\nu_{\max}$ , 1750  $\text{cm}^{-1}$  [Found: C, 81.2; H, 11.0%; m.wt. 454 (by mass spectrum).  $C_{31}H_{50}O_2$  requires C, 81.9; H, 11.1%; m.wt. 454].

Both putrone and putrol further contain one double bond as shown by positive tnm test, ir and nmr spectra; it is sterically hindered because it is not reducible even by Adams catalyst and further it is trisubstituted as shown by ir spectra of these compounds and putrol acetate ( $\nu_{\max}$ , 788 and 840  $\text{cm}^{-1}$ ) and

by nmr data  $\delta$  5.37 ppm (broad ~ 12 cps) in putrone,  $\delta$  5.28 ppm (broad ~ 10 cps) in putrol and  $\delta$  5.1 ppm (broad ~ 10 cps) in putrol acetate. The possibility of the presence of either two conjugated double bonds or a double bond conjugated with the carbonyl group is ruled out on the basis of uv spectrum which does not show any absorption band in  $\text{CHCl}_3$  medium. Since there are one carbonyl group and only one double bond, the new triterpenes seem to be pentacyclic belonging to the *nor*-type, which is rather rare in the ubiquitous field of triterpenes.

The nmr spectra of putrone, putrol and its acetate in  $\text{CDCl}_3$  show signals for 7–8 methyl groups, among which the most remarkable signal is at  $\delta$  0.57 ppm in the ketone which moves downfield to  $\delta$  0.85 ppm in the alcohol and its acetate. Hence one methyl group in the ketone is highly shielded due to CO group which effect disappears in the alcohol and its acetate. A similar downfield shift has recently been observed for the signal of the shielded 18 methyl protons ( $\delta$  0.56 ppm) in hop-21-ene which moved downfield to  $\delta$  0.69 ppm in hopane.<sup>5</sup> The presence of gem dimethyl group is indicated by  $\nu_{\max}$ , 1385 and 1349  $\text{cm}^{-1}$ .

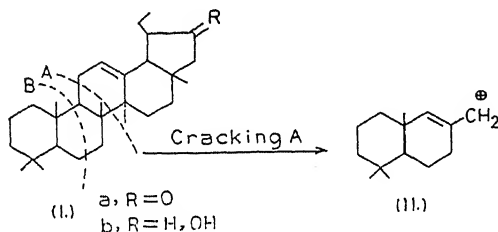
The ketone shows positive Zimmermann test (violet colour) indicating the presence of a methylene group adjacent to a keto group which is also discernible in the nmr spectrum; two proton resonances centered at  $\delta$  2.40 ppm ( $J=5$  cps) in the ketone disappears in the nmr spectra of the alcohol and its acetate.

Mass spectrum of putrone (70 eV) m/e (relative abundance): 41(14.3), 43(7.8), 53(3.1), 55(20.0), 67(9.0), 69(27.1), 77(4.0), 79(7.1), 81(15.9), 83(10.0), 91(9.1), 93(10.3), 95(28.3), 105(12.0), 107(10.9), 109(34.3), 119(15.4), 121(8.6), 123(24.0), 137(11.5), 145(6.0), 147(5.2), 149(3.7), 163(17.0), 177(6.0), 179(38.6), 191 (base ion) (97.1), 205(20.0), 206(86.0), 207(12.0), 218(4.0), 231(14.3), 232(17.7), 243(13.4), 257(10.9), 271(7.8), 286(3.0), 395(M-15)<sup>+</sup>(7.4) and 410(M)<sup>+</sup>(33.1).

Mass spectrum of putrol acetate (70 eV) m/e (relative abundance): 41(12.0), 43(30.9), 53(4.5), 55(30.9), 67(13.2), 69(45.4), 77(6.0), 79(12.0), 81(29.1), 83(12.0), 91(15.4), 93(18.7), 95(41.8), 105(20.3), 107(20.3), 109(45.4), 119(32.7), 121(20.0), 123(29.1),

131(9.8), 133(12.7), 137(11.6), 145(10.9), 147(11.1), 149(5.0), 159(12.5), 163(16.3), 173(9.6), 177(7.0), 179(29.1), 191(92.7) (base ion), 206(70.9), 216(10.9), 218(4.0), 227(3.6), 232(3.1), 241(4.0), 248(2.5), 255(2.0), 275(9.1), 289(9.6), 301(4.7), 315(2.3), 379(2.0), 394(M-60)<sup>+</sup> (9.3), 439 (M-15)<sup>+</sup> (8.1) and 454 (M<sup>+</sup>) (49.1).

From the above data, it can be seen that the base ion is of *m/e* 191 and the other common fragments in the cracking of putrone and putrol acetate have *m/e* 218, 206, 205, 179 and 163 besides others in the lower region. They seem to comprise that part of the molecule which do not have CO or CHOAc groups. The base ion peak of 191 has been observed earlier in such pentacyclic triterpenes as have a double bond in 12 position and the substitution of rings A, B and C as shown in formula I (e.g., in  $\Delta^{12}$ -oleanene<sup>6</sup> and hopene-27). Taking this and other features established above into consideration, a plausible structure for putrone and putrol may be written as Ia and Ib respectively. The base ion peak would then correspond to structure II which represents retro-Diels-Alder product of I. A peak of *m/e* 137 in mass spectra of both putrone and putrol acetate representing rupture of the C<sub>(6)</sub>-C<sub>(7)</sub> and C<sub>(9)</sub>-C<sub>(10)</sub> bonds and removal of H corresponds to ring A.<sup>8</sup> The relative positions of keto and C<sub>17</sub>-methyl can be deduced from the shielding effect as found in hop-21-ene and those of methyl and ethyl groups on the basis of possible biogenesis. The present structure leaves unsettled a number of points. To understand these, further work is in progress.



**Fraction F ( $\beta$ -Amyrin).**—Fraction F (600 mg.) crystallised from chloroform-methanol mixture as colourless needles, m.p. 199–200°;  $[\alpha]_D + 85.1^\circ$  (c, 1.01). It was found identical with  $\beta$ -amyrin on tlc, in ir spectrum and as acetate, and by conversion to  $\beta$ -amyrenone,

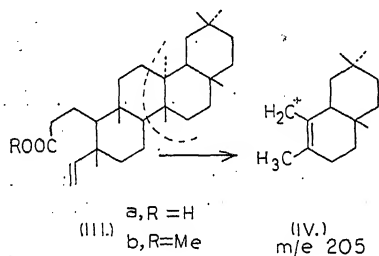
**Fraction G (Stigmasterol).**—Fraction G crystallised from chloroform-methanol mixture as colourless long needles, m.p. 170°;  $[\alpha]_D - 49^\circ$  (c, 0.94); tlc with solvents B and C gave single spots; LB reagent gave a green colour and ir spectrum did not show the presence of gem-dimethyl group showing the sterol character. It formed an acetate which crystallised from methanol as colourless prisms, m.p. 140–41°;  $[\alpha]_D - 32.6^\circ$  (c, 0.92). That it is stigmasterol was confirmed by comparative tlc and ir spectra. The presence of this sterol in this plant is noteworthy because it is generally present in *Leguminous* plants.

**Fraction H (Putranjivic acid, III a).**—Fraction H (100 mg.) crystallised from chloroform-methanol mixture as colourless crystals, m.p. 177–79°;  $[\alpha]_D - 15^\circ$  (c, 0.4); tlc with solvents D, E and F showed single spots. It forms an insoluble salt with aqueous sodium hydroxide and has a carboxyl group as shown by the carbonyl stretching frequency a  $\nu_{\max}$  1730  $\text{cm}^{-1}$  (s) and by the ready formation of a methyl ester with diazomethane which crystallised from methanol as colourless prisms, m.p. 133–35°;  $\nu_{\max}$  1754  $\text{cm}^{-1}$  (ester C=O) [Found: C, 81.4; H, 11.1%; mol. wt. 456 (by mass spectrum). C<sub>31</sub>H<sub>52</sub>O<sub>2</sub> requires C, 81.5; H, 11.5%; mol. wt. 456]. Since the physical constants of the acid and its methyl ester do not agree with any acid and its methyl ester reported earlier, the acid is considered to be a new substance and hence named *putranjivic acid*.

to be a new substance and hence named *Putranjivic acid*. The presence of a monosubstituted (or vinyl) double bond [ $\nu_{\max}$  1,650 (w), 1,280 (w), 990 (s), 909 (s)] which is further confirmed by the absence of olefinic methyl signals and by the presence of complex multiplet of three olefinic protons in their nmr spectra between  $\delta$ 4.78–5.80 ppm. Since there is only one double bond, the acid should be a tetracyclic triterpenic acid. The presence of a methylene group adjacent to CO<sub>2</sub>H is indicated by a triplet of two protons centered at  $\delta$ 2.43 ppm. Hence CO<sub>2</sub>H is not linked to a secondary or tertiary carbon atom; this is also shown by methyl signal of CO<sub>2</sub>CH<sub>3</sub> at  $\delta$ 3.67 ppm, which is downfield by nearly 0.1 ppm. as compared to C<sub>17</sub>-CO<sub>2</sub>CH<sub>3</sub>.<sup>9</sup> Hence the acid appears to be a seco-acid like nyctanthic and roburic acids.<sup>10</sup> The nmr spectra of putranjivic acid and the methyl ester show seven tertiary

methyl groups between 0.9–1.25 ppm. The mass spectrum of methyl putranjivate (70 eV),  $m/e$  (relative abundance) is as follows: 41(20), 43(12), 55(33.3), 67(21), 69(41), 77(5.5), 79(14.5), 81(50), 91(9), 93(23.3), 95(66.6), 97(9), 107(25), 109(36.7), 111(13.3), 121(28.2), 123(35), 137(21.7), 149(18.7), 151(11.7), 163(16.7), 177(11), 191(14), 195(3), 205 (96.7), (base ion peak), 218(22.6), 223(17.6), 233(7.5), 236(5.5), 245(4), 250(17.6), 261(3), 263(2), 273(13.6), 289(35), 291(3), 301(6.3), 318(2.2), 331(3.7), 359(1), 374(2), 387(3.3), 425(4.33) ( $M-31$ )<sup>+</sup>, 441 ( $M-15$ )<sup>+</sup> (10.3), 456(27.3) (molecular ion peak ( $M^+$ )).

The base ion peak at 205 indicates that the skeleton is like that of friedlan<sup>11,12</sup> and there are no substituents in rings D and E. It is, therefore, tentatively suggested that putranjivic acid has structure IIIa, methyl putranjivate III b and the base ion IV. Further work to get this acid or its derivative from friedelin is in progress.



In order to check that no other component has been lost along with chlorophyll in the first chromatography of the plant extract, the whole residue of benzene extract of air-dried leaves (1,100 g.) has been subjected straight to saponification with methanolic potash using some benzene in order to make the mixture homogeneous. The neutral fraction gave a misolid which was separated on silica gel column into four major fractions as described earlier. The first fraction was the aliphatic

hydrocarbon (0.5 g.); the second one gave putrone (1.1 g.) and putrol (0.3 g.); the third one gave  $\beta$ -amyrin (9 g.) and the fourth one gave stigmasterol (0.5 g.). However, the acid part gave difficulty in separating putranjivic acid from the associated fatty acid. This method is thus better for isolating neutral components in good yields.

While writing up this paper, a publication by Sen-Gupta and Djerassi *et al.*<sup>13</sup> reached us. It describes the isolation of friedelin and a new triterpene-diketone named *Putranjivadiene* from the whole plant of *Putranjiva roxburgii*. They have established that their new compound is friedlan-3, 7 dione. It is not clear to us how the whole plant could be used for extraction; in fact, the plant is a tree. Since none of these two compounds have been isolated by us from the leaves, it is considered that they might have used some other part of the plant.

1. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, C.S.I.R., New Delhi, 1956.
2. Kjaer, A. and Friis P., *Acta Chem. Scand.*, 1962, **16**, 936.
3. Simonsen, J. and Ross, W. C. J., *The Terpenes*, Cambridge University Press, 1957, **4**, 175.
4. Savoir R., Träsch, B. and Kaisin M., *Tetrahedron Letters*, 1967, p. 2129.
5. Corbett, R. E and Smith, R. A. J., *J.C.S. (C)*, 1967, p. 1622.
6. Karliner, J. and Djerassi, C., *J. Org. Chem.*, 1966, **31**, 1945.
7. Pandey, G. N. and Mitra, C. R., *Tetrahedron Letters*, 1967, p. 4683.
8. Enzell, C., *Acta Chem. Scand.*, 1961, **15**, 1303.
9. Shamma, M., Glick, R. E. and Mumma, R. O., *J. Org. Chem.*, 1962, **27**, 4512.
10. Halsall, T. G. and Aplin, R. T., *Fort. Chem. Org. Naturstoffe*, 1964, **22**, 176.
11. Courtney, J. L. and Shannon, J. S., *Tetrahedron Letters*, 1963, p. 13.
12. Shannon, J. S., Macdonald, C. G. and Courtney, J. L., *Ibid.*, 1963, p. 173.
13. Sen Gupta, P., Chakraborty, A. K., Duffield, A. M., Durham, L. J. and Djerassi, C., *Tetrahedron*, 1968, **21**, 1205.

## SIMILARITIES IN THE RESPONSE TO CHROMOSOME DOUBLING AND GIBBERELLIN APPLICATION IN SOME PLANTS

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THERE is greater scope for polyploidy breeding in plants grown for fodder and ornamental purposes since seed fertility, which is usually reduced in autopolyploids, is not of primary importance in such plants.<sup>1-4</sup> Tetraploids were hence produced by colchicine treatment in the fodder plants, Berseem (*Trifolium alexandrinum*) and Senji (*Melilotus indica*) in 1954 and in the ornamental plants, Snapdragon (*Antirrhinum majus*), Larkspur (*Delphinium ajacis*) and Acroclinium (*Helip-  
terum roseum*) in 1957 at the Indian Agricultural Research Institute, New Delhi.<sup>5-6</sup> Induced tetraploids of Snapdragon and Larkspur showed a striking improvement in flower size over their respective diploids, whereas those of Acroclinium did not differ markedly from the diploid parent.<sup>6</sup> Such a differential response to chromosome doubling was also observed in the induced tetraploids of Berseem and Senji.<sup>5</sup> Autotetraploid Berseem was consistently superior to the diploid in fodder yield and has been released for general cultivation under the name "Pusa Giant Berseem"<sup>7</sup> while tetraploid Senji did not show any improvement over the diploid parent.<sup>8</sup>

A comparative study revealed that Berseem and Senji differ prominently in initial cell size, the cells of diploid Senji being nearly double in size than that of diploid Berseem.<sup>5</sup> Stebbins<sup>4</sup> has postulated that the optimum cell volume may be reached in many plants in the diploid state itself and that if in such plants the cell volume is further increased through colchicine treatment, the consequent

effect on physiologic efficiency is deleterious and hence is of negative selection value. Since cell enlargement is also a characteristic response to exogenous application of gibberellin,<sup>9,10</sup> a study was undertaken to ascertain whether there is a parallelism in the favourable response of plants to the application of colchicine and gibberellin.

Observations were made on plants grown in pots under comparable growth conditions. There were three sets for every species—one set of diploids to serve as control, another set of diploids for gibberellin treatment and one set of induced tetraploids. Each set consisted of 15 plants in the ornamentals and 25 plants in Berseem and Senji. Leaves of eight week-old plants of ornamental and nine week-old fodder plants were sprayed with 100 p.p.m. gibberellic acid (GA) through an atomiser applying 1 mg. of GA per plant. Observations on cell size were taken 7 to 10 days after spraying. Leaf samples from the three sets of each species were taken from comparable growth regions and the peelings from the lower epidermis were used for observing cell size. For measuring area, cells were traced on a centimeter square graph paper at bench level with the help of a camera lucida. Observations on 20 cells were recorded for each plant and the data were statistically analysed (Table I).

The data reveal that response in terms of increased cell size is significant, for both GA and chromosome doubling, only in those species whose tetraploid forms are promising. Thus.

TABLE I  
Effects of exogenous gibberellic acid (GA) and induced polyploidy on cell size

Material		Somatic chromosome number	Mean cell size (expressed as percentage of the controls)		T. values for comparing means treatments vs. controls		Commercial value of induced tetraploids
			G.A. effect	Polyploidy effect	G.A. effect	Polyploidy effect	
Snapdragon	..	16	142.72	164.61	4.61*	4.89*	Good
Larkspur	..	16	135.46	150.18	3.18*	4.06*	Good
Acroclinium	..	14	108.27	117.54	1.47	1.52	Poor
Senji	..	16	112.24	119.32	1.22	1.45	Poor
Berseem	..	16	139.13	156.25	3.43*	4.51*	Good

\* T value at 5% level = 2.045.

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the present study supports the views of Schwanitz<sup>11</sup> and Stebbins<sup>4</sup> that an optimum cell size exists for each species and that this size may be attained through natural selection at the diploid level in some species and at higher ploidy levels in others. The favourable response to induced polyploidy will then depend upon whether or not the optimum cell size has already been attained in the initial population chosen for colchicine treatment.

If this correlation between GA and polyploidy effects is generally operative, an interesting application of the present observation will be that positive response to GA can be used as a sieve for selecting plants for the induction of polyploidy. This technique may be particularly useful in ornamental and fodder plants but not in crops where the economic part is the seed, since in such plants increased grain size is not the only component

of increased yield and the seed sterility associated with autopolyploidy also reduces the utility of the polyploid.

1. Emsweller, S. L. and Ruttle, N. L., *Amer. Nat.*, 1941, **75**, 310.
2. Levan, A., *Hereditas*, 1942, **28**, 245.
3. Emsweller, S. L., *Proc. Amer. Soc. Hort. Sci.*, 1948, **51**, 565.
4. Stebbins, G. L., *Brookhaven Symp. Biol.*, 1956, **9**, 37.
5. Sikka, S. M., Swaminathan, M. S. and Mehta, R. K., *Nature* (London), 1958, **181**, 32.
6. Rana, R. S., *Assoc. I.A.R.I., Dissertation*, 1959.
7. Mehta, R. K. and Swaminathan, M. S., *Indian Fmg.*, 1965, **15** (6), 4.
8. —, Subramanyam, K. N. and Swaminathan, M. S., *Indian J. Genet.*, 1963, **23**, 67.
9. Stowe B. B. and Yamaki, T., *Ann. Rev. Plant Physiol.*, 1957, **8**, 181.
10. Haber, A. H. and Luippold, H. J., *Amer. J. Bot.*, 1960, **47**, 140.
11. Schwanitz, F., *The Origin of Cultivated Plants*, Harvard University Press, Cambridge, 1966.

## DRY MATTER PRODUCTION IN SUN AND SHADE LEAVES AND A SIMPLE METHOD FOR THE MEASUREMENT OF PRIMARY PRODUCTIVITY

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WITH increasing emphasis in recent years on the evaluation of primary productivity the role of sun and shade leaves in production has drawn considerable attention. Although some amount of work is available on the differential behaviour of sun and shade leaves (often referred to as upper and lower leaves) with regard to their dry weight per unit area,<sup>1-3</sup> a direct evaluation of their capacity for dry matter production is lacking in ecological literature. In order to investigate, therefore, the gross productivity of these two types of leaves when exposed to their normal as well as reciprocal light conditions, a few experiments were conducted with *Bougainvillea spectabilis* during April 1968. The same are discussed briefly here.

Gross production was measured through the increase in the dry weight of leaf discs of one square centimeter area obtained with the help of a cork borer. Twigs of current growth with equal number of nodes were selected from the permanently shaded (10% of full daylight) and upper exposed areas from shrubs growing in the botanical garden of the Banaras Hindu University at 8 a.m. The leaves obtained from shaded and exposed areas are termed

shade and sun leaves respectively. In order to avoid the error due to changes in the area of the leaves<sup>4</sup> they were immersed in water till fully turgid before cutting out the discs. The discs were then placed over cotton pads kept constantly wet in uncovered Petri dishes. Cotton pads were necessary to check excessive heat which otherwise would kill the discs within a short period when kept in full sunlight. Twenty discs were placed in each Petri dish and three such Petri dishes were used for each of the following treatments: sun leaves in full daylight, sun leaves in shade, shade leaves in full daylight, shade leaves in shade, and sun and shade leaves in a dark chamber with 40% KOH placed in another Petri dish. Presence of KOH solution was necessary as we have gathered some evidence of substantial dark fixation of CO<sub>2</sub> in this plant which will be published elsewhere.

At the start of the experiment an equal number of discs, both from sun and shade leaves, were oven-dried at 80° C. for recording the initial dry weight. Increase in the dry weight of the discs at the end of six hours treatment is taken as the apparent photosynthesis or net production and the decrease in



the dry weight in dark as respiration. Sum total of these two values represents gross production. This method has the advantage over that used by Denny<sup>5</sup> inasmuch as the photosynthate is not translocated out of the photosynthetic area. For experimentation in reduced light intensity the shade of the same shrub was used as the spectral composition of the light is liable to be different in shade of different plants.<sup>6</sup>

TABLE I  
Initial dry weight and gross and net  
productivity of sun and shade leaves

	Sun leaf	Shade leaf
Control (g./m. <sup>2</sup> ) ..	912±17.2	567±10.2
Six hours in full sunlight (g./m. <sup>2</sup> )	995±15.3	643±1.2
Six hours in shade (g./m. <sup>2</sup> )	981±22.8	596±15.3
Six hours in dark (g./m. <sup>2</sup> )	892±2.9	555±11.9
Respiration (g./m. <sup>2</sup> /hr.) ..	3.3	2.0
Gross productivity (g./m. <sup>2</sup> /hr.) in sun	17.1	14.66
Gross productivity (g./m. <sup>2</sup> /hr.) in shade	14.80	6.80
Net productivity in sun (g./m. <sup>2</sup> /hr.)	13.8	12.66
Net productivity in shade (g./m. <sup>2</sup> /hr.)	11.5	4.80
Gross productivity in sun (g./m. <sup>2</sup> /day)	205.2	175.92
Gross productivity in shade (g./m. <sup>2</sup> /day)	177.6	81.60
Respiration (g./m. <sup>2</sup> /day) ..	79.2	48.0
Net productivity in sun (g./m. <sup>2</sup> /day)	126.0	127.92
Net productivity in shade (g./m. <sup>2</sup> /day)	98.4	33.6

Table I indicates that the dry weight of the shade leaves per unit area is significantly lower than that of the sun leaves ( $p < 0.001$ ). It is further evident that both the gross and net productivities are higher in sun leaves as compared to the shade leaves ( $p < 0.001$ ) and  $p < 0.001$  respectively) under their normal light regimes. However, when the sun leaves are exposed to shade for limited period there is no appreciable decrease in their productivity. On the other hand, the shade leaves when exposed to full daylight increase their photosynthetic rate more than twice the normal value. When the data are converted to per day basis (taking 12 hr. light and 12 hr. dark period) similar trend in productivity is obtained but the net productivity of the shade leaves exposed to full sunlight equals to that of sun leaves under their normal light condition and is more than that of the sun leaves exposed to shade. From these observations it is clear that the shade leaves have inherent capacity to photosynthesize at the same rate as the sun leaves and therefore they also contribute significantly towards plant productivity

as and when they are exposed even for a brief period to direct sunlight on account of sun flecks and changes in the light climate due to the action of wind, etc.

In the light of above observations an estimation of the amount of chlorophyll present seems necessary. Total chlorophyll ( $a + b$ ) in sun and shade leaves was determined in 80% acetone extract.<sup>7</sup> The ratio chlorophyll  $a$ /chlorophyll  $b$  was determined through their respective concentrations.<sup>8</sup> It was thus found out that sun leaves contain 84.5 mg./m.<sup>2</sup> chlorophyll while the shade leaves have about twice this amount (182.9 mg./m.<sup>2</sup>). The ratio chlorophyll  $a$ /chlorophyll  $b$  amounts to 1.2 in sun leaves and to 5.3 in shade leaves. It is obvious therefore that in full sunlight even lesser amount of chlorophyll per unit area photosynthesizes much more and hence sun leaves are more efficient energy trapping system. The increased amount of chlorophyll in shade leaves may, however, be helpful in stimulating production as and when sufficient light is available for a brief period. The present finding is in conformity with those of Harder<sup>9</sup> Seybold and Egle,<sup>10</sup> and Egle<sup>11</sup> who have reported greater amount of total chlorophyll in shade plants. However, contrary to their observations the shade leaves of *B. spectabilis* contain lesser amount of chlorophyll  $b$  as compared to the sun leaves. It has been established that chlorophyll  $b$  improves the utilization of light between 450 and 480 m $\mu$ , which is abundant in the shade of foliage.<sup>12</sup> Thus, in the sun leaves of the present species, containing more chlorophyll  $b$ , the photosynthetic efficiency is not significantly reduced in shade. Therefore, on a cloudy day also the sun leaves may photosynthesize with the same efficiency as on sunny day. On the other hand the shade leaves, having more chlorophyll  $a$ , increase their photosynthesis considerably when exposed to full sunlight.

1. Whittaker, R. H., *Ecology*, 1962, **43**, 357.
2. —, and Garfine, V., *Ibid.*, 1962, **43**, 120.
3. —, Cohen, N. and Olsen, J. S., *Ibid.*, 1963, **44**, 806.
4. Thoday, D., *Proc. Roy. Soc. (London)*, 1909, **82 B**, 1.
5. Denny, F. E., *Amer. Jour. Bot.*, 1930, **17**, 818.
6. Cummings, B. G., *Canad. J. Bot.*, 1963, **41**, 1211.
7. Arnon, D. I., *Pl. Physiol.*, 1949, **24**, 1.
8. Barnes, H., *Apparatus and Methods of Oceanography*. Part I. *Chemical*, George Allen and Unwin Ltd., London, 1959.
9. Harder, R., *Planta*, 1933, **20**, 699.
10. Seybold, A. and Egle, K., *Ibid.*, 1937, **26**, 491.
11. Egle, K., *Ibid.*, 1937, **26**, 546.
12. Rabinowitch, E. I., *Photosynthesis and Related Processes*. Vol. II, Interscience Publishers, New York, 1951.

## STUDIES ON RODENT CHROMOSOMES

Part IV. Chromosomes of a Metad, *Millardia meltada* (GRAY), and an Account of an Aberrant Karyotype in a Male

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**C**HROMOSOMAL patterns in animal populations are indicators of cytogenetic variations which might provide a basis for understanding the evolutionary mechanisms. In this report we describe the chromosomes of a metad, *Millardia meltada* (Muridae) from somatic and germinal tissues. Description of a male with an aberrant karyotype is also reported and its possible significance discussed.

Metads are soft-furred field rats with large round ears. They live in burrows, chiefly near cultivated fields, and are known to damage paddy and other crops. Animals were collected from the environs of Kolar, South India, during the month of June, 1967. Chromosome preparations from bone marrow, cornea and testis were made and karyotypes prepared according to the methods described earlier.<sup>4</sup>

## OBSERVATIONS

**Somatic chromosome number and morphology.**—Out of 110 well-spread metaphases, 86% showed that there are 26 chromosomes in both sexes (Table I). The chromosomes are all rod-shaped and can be arranged in three groups, large, medium and small. In female there are six pairs in the first group, five pairs in the second and two pairs in the third group (Figs. 1 and 2). Although the identification of the X chromosome is difficult, a comparison of male and female karyotypes has led us to designate one of the large chromosomes of Group I as the X chromosome. The Y chromosome, on the other hand, is the smallest in the complement (Fig. 2).

TABLE I  
The chromosome counts in *M. meltada*

Sex	Chromosome counts				Total cells counted
	<25	25	26	27	
Female	..	1	43	6	50
Male	2	5	52	1	60
Aberrant Male	6	44	..	..	50

**Male meiotic chromosomes.**—The spermatogonial cells also show 26 chromosomes (Fig. 3), all being rod-shaped. However, in certain prometaphase figures, it is possible to see a short

telomeric segment clearly in some chromosomes which indicates that they are acrocentric. The X chromosomes cannot be identified with certainty but the Y chromosome is marked at the spermatogonial anaphase as it is positively heteropycnotic (Fig. 4).

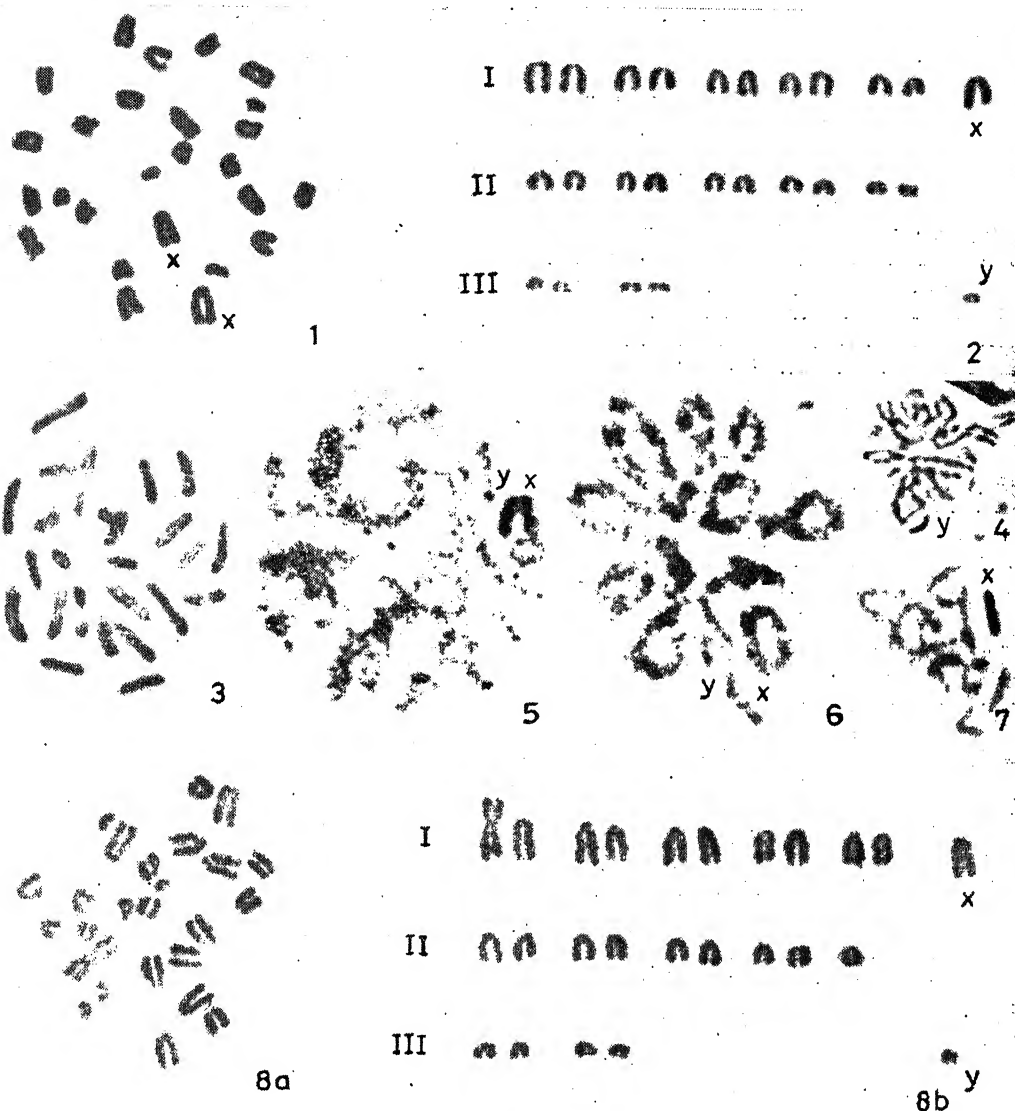
During early meiotic divisions the sex chromosome complex stands out clearly in the sex vesicle amidst autosomes. It is possible to make out two regions in the long X chromosome, a darkly staining region (heteropycnotic) which is approximately 1/3 the length of the chromosome and the rest which is lightly stained. The Y chromosome is heteropycnotic throughout its length (Fig. 5). Sometimes a close association of the heteropycnotic portion of the X and the Y chromosome gives an impression of crossing over between them. However, a typical chiasma between them has not been observed. They show a characteristic end-to-end association at later stages (Fig. 6).

**Aberrant karyotype.**—One male individual apparently with normal phenotype showed an aberrant karyotype. There are 25 chromosomes, one less than the usual number (Table I). An examination of the karyotype reveals that there is a large submetacentric chromosome and an unpaired one in the second group. Fusion of two chromosomes might account for this (Figs. 8 a and b). It is difficult to say if the fusion is between two autosomes or between an autosome and a sex chromosome.

## DISCUSSION

The present study shows an evidence of departure from normal chromosomal pattern in individuals from natural populations without involving any noticeable phenotypic change. Similar deviations have often been reported in several groups of animals<sup>3,6</sup> and in man.<sup>1</sup> In *Millardia*, the fusion of two chromosomes has resulted in the formation of a large submetacentric chromosome and reduction of the chromosome number from 26 to 25.

Of the possible mechanisms for the formation of metacentric chromosomes, Ruddle<sup>5</sup> has suggested a terminal union of two acrocentrics, while Hsu *et al.*<sup>2</sup> feel it could be due to centric breakage, followed by sister chromatid fusion.



FIGS. 1-8. Fig. 1. Metaphase plate of female,  $\times 1,900$ . Fig. 2. Male karyotype,  $\times 1,900$ . Fig. 3. Spermatogonial metaphase,  $\times 1,900$ . Fig. 4. Polar view of spermatogonial anaphase showing heteropycnotic Y chromosome,  $\times 1,200$ . Fig. 5. Meiotic prophase showing sex vesicle enclosing the sex chromosomes. Note that the entire Y and part of X heteropycnotic,  $\times 1,900$ . Fig. 6. Early metaphase I showing end-to-end association of X and Y,  $\times 1,900$ . Fig. 7. Secondary spermatocyte showing the positively heteropycnotic X chromosome,  $\times 1,200$ . Fig. 8. Metaphase (a) and karyotype of the aberrant male (b). Note the sub-metacentric chromosome,  $\times 1,900$ .

According to the former, fusion can result in a submetacentric or metacentric chromosome. In the latter, only a metacentric is produced. In *Millardia melitana* the submetacentric chromosome is probably due to the fusion of two unequal acrocentric chromosomes indicating the operation of the former mechanism.

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1. Chandra, H. S. and Hungerford, D. A., *Cytogenetics*, 1963, 2, 34.
2. Hsu, T. C., Billen, D. and Levan, A., *J. Natl. Cancer Inst.*, 1961, 27, 515.
3. Nadler, C. F., *Cytogenetics*, 1965, 4, 37.
4. Rao, S. R. V., Shah, V. C. and Champaka Seshadri *Chromosoma*, 1968, 23, 309.
5. Ruddle, F. H., *Cancer Research*, 1961, 21, 885.
6. White, M. J. D., *Animal Cytology and Evolution* 2nd Ed., Cambridge University Press, 1954.

## LETTERS TO THE EDITOR

FINE STRUCTURE ANALYSIS AND  
ISOTOPE EFFECT STUDIES IN  
B-X, C-X AND D-X SYSTEMS  
OF SbO MOLECULE

As compared to NO, PO, AsO and BiO molecules, the existing knowledge of the nature and properties of the electronic states and electronic structures of the related molecule SbO, is rather meagre.<sup>1-3</sup>

The rotational structures of some of the bands of B-X, C-X and D-X systems have been studied in the second order of a 21 ft. concave grating spectrograph at a dispersion of 0.625 Å/mm. The object of the work is to confirm the nature of the electronic transition involved in each of the systems and the vibrational quantum numbering of the bands by a study of the vibrational and rotational isotopic shifts corresponding to the less abundant molecule Sb<sup>123</sup>O<sup>16</sup>.

The B-X<sup>2</sup>Π System

The rotational analysis of the (0,0) sub-bands of this system, while confirming the transition to be <sup>2</sup>Σ'-X<sup>2</sup>Π<sub>r</sub>, has led to a determination of the rotational constants of the upper and lower states, which differ from those of early workers.<sup>1-3</sup> A doubling of the rotational lines in some of the branches of the

been determined from the analysis. The rotational constants of the zero vibrational level of the ground state agree very well with those of B-X<sup>2</sup>Π system. The vibrational quantum numbering of three bands has been confirmed by detailed studies of the vibrational and rotational isotope effect due to Sb<sup>123</sup>O<sup>16</sup> molecule. No Λ-doubling of the lower state has been observed even at high 'J' values.

The D-X<sup>2</sup>Π System

The (0,2), (0,1), (1,1) and (1,2) bands of D-X<sup>2</sup>Π<sub>r</sub> system have been analysed and found to involve a transition <sup>2</sup>Π<sub>(r)</sub>-<sup>2</sup>Π<sub>1</sub>. By a detailed study of the vibrational and rotational isotope effect of antimony, it has been shown that the Shimauchi's vibrational quantum numbering of the upper state should be increased by one unit. Thus the (0,2), (0,1), (1,2) and (1,1) are to be classified as (1,2), (1,1), (2,2), and (2,1) respectively. The rotational constants of the vibrational levels 1 and 2 of the X<sup>2</sup>Π state are in agreement with those derived from the analysis of the B-X<sup>2</sup>Π and C-X<sup>2</sup>Π systems.

Table I gives the summary of the rotational constants of the X, B, C and D states of SbO molecule.

TABLE I

Ground State— <sup>2</sup> Π <sub>r</sub>	B <sup>2</sup> Σ—State	C <sup>2</sup> Δ—State	D <sup>2</sup> Π (r)-State
B <sub>0</sub> ' = 0.351 <sub>0</sub> cm. <sup>-1</sup>	B <sub>0</sub> ' = 0.321 <sub>2</sub> cm. <sup>-1</sup>	B <sub>0</sub> ' = 0.292 <sub>6</sub> cm. <sup>-1</sup>	B <sub>0</sub> ' = 0.268 <sub>7</sub> cm. <sup>-1</sup>
B <sub>0</sub> '' = 0.352 <sub>5</sub> "	D <sub>0</sub> ' = 0.57 × 10 <sup>-6</sup> "	B <sub>1</sub> ' = 0.291 <sub>7</sub> "	B <sub>0</sub> '' = 0.266 <sub>0</sub> "
B <sub>1</sub> ' = 0.349 <sub>5</sub> "	σ <sub>0</sub> ' = 1.927 × 10 <sup>-8</sup> cm.	B <sub>2</sub> ' = 0.291 <sub>0</sub> "	B <sub>1</sub> '' = 0.264 <sub>2</sub> "
B <sub>2</sub> ' = 0.348 <sub>0</sub> "	I <sub>0</sub> ' = 87.12 × 10 <sup>-10</sup> gm.cm. <sup>2</sup>	B <sub>3</sub> ' = 0.290 <sub>5</sub> "	τ <sub>0</sub> ' = 2.06 × 10 <sup>-8</sup> cm.
α <sub>0</sub> ' = 0.001 <sub>5</sub> "		D <sub>0</sub> ' = 0.33 × 10 <sup>-6</sup> "	I <sub>0</sub> '' = 104.14 × 10 <sup>-10</sup> gm.cm. <sup>2</sup>
r <sub>e</sub> ' = 1.841 × 10 <sup>-8</sup> cm.		α <sub>0</sub> '' = 0.000 <sub>6</sub> "	A ≈ 2273.4 cm. <sup>-1</sup>
r <sub>e</sub> '' = 79.56 × 10 <sup>-40</sup> gm.cm. <sup>2</sup>		r <sub>e</sub> ' = 2.018 × 10 <sup>-8</sup> cm.	
eff. = 2274.3 cm. <sup>-1</sup>		I <sub>c</sub> ' = 95.63 × 10 <sup>-10</sup> gm.cm.	

The subscript 'δ' refers to <sup>2</sup>Π<sub>3/2</sub> state.

no component systems has been attributed to the isotope effect of antimony. The analysis reveals that the Λ-doubling of the <sup>2</sup>Π state in the form of combination defect and the spin splitting in the upper state are negligibly small.

The C-X<sup>2</sup>Π System

The rotational analysis of (2,0), (3,0) and (1,1) bands of C-X<sup>2</sup>Π system shows that the transition is <sup>2</sup>Δ<sub>3/2</sub>-X<sup>2</sup>Π. The rotational constants of the upper <sup>2</sup>Δ and the lower <sup>2</sup>Π have

Spectroscopy Lab., D. V. KRISHNA RAO.  
Dept. of Physics, P. TIRUVENGANNA RAO.  
Andhra University,  
Visakhapatnam-3, March 19, 1968.

1. Lakshman, S. V. J., *Z. Phys*, 1960, 158, 367; *Ibid.*, 1960, 158, 386.
2. Singh, R. B., *Proceedings of Indian Science Congress*, 1967.
3. Shimauchi, M., *Science of Light*, 9, November, 1960.

# N.M.R. STUDY OF BARIUM DITHIONATE DIHYDRATE, BaS<sub>2</sub>O<sub>6</sub>·2H<sub>2</sub>O

X-RAY analysis of barium dithionate dihydrate has been carried out by a number of investigators.<sup>1</sup> According to Rausell-Colom and Garcia Blanco the crystal belongs to the monoclinic class with space group C<sub>2h</sub><sup>6</sup>-C<sub>2</sub>/c; the unit cell dimensions are a = 12.483 Å, b = 6.66 Å and c = 9.195 Å, β = 111° 38' and there are four molecules per unit cell. To obtain information about the position of hydrogen atoms and the orientation of the interproton vectors, Proton Magnetic Resonance study of the substance was carried out using the well-known Pake technique.<sup>2</sup> The present note reports the results briefly.

The experiments have been carried out at room temperature with a number of crystals formed by slow evaporation of a saturated solution of barium dithionate dihydrate. A broad line spectrometer has been constructed in this laboratory and used in conjunction with a Varian 12" magnet and power supply. The steady magnetic field is modulated by 140 cycles/sec. with an amplitude of about one gauss. The absorption derivatives are obtained on a Varian Recorder. The crystal is rotated about the c'-axis which is perpendicular to the ab plane.

Analysis of the Resonance Spectra has revealed two Pake curves, showing two different orientations. The values of the constants obtained are:

$$\begin{aligned} 2a &= 10.15 \text{ Å} & \phi_0 &= -69^\circ & \delta &= 21^\circ & \gamma &= 1.62 \text{ Å} \\ 2a &= 10.25 \text{ Å} & \phi_0 &= 70^\circ & \delta &= 21^\circ & \gamma &= 1.60 \text{ Å} \end{aligned}$$

The direction angles of the p-p vectors determined from these values of δ and φ<sub>0</sub> are w.r. to crystallographic axes

$$\begin{aligned} \alpha_0 &= 151^\circ & \beta_0 &= 70^\circ & \gamma_0 &= 90^\circ \\ \alpha_0 &= 29^\circ & \beta_0 &= 70^\circ & \gamma_0 &= 90^\circ \end{aligned}$$

Using r = 1.62 Å, and assuming the O-H distance as 1 Å, the H-O-H angle is found to be 109°, agreeing with the generally accepted value but smaller than that calculated from the structure, which is 122°. This smaller value suggests that the hydrogen bonds are not 'straight'.

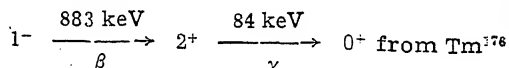
The author is greatly indebted to Prof. K. R. Rao for his valuable guidance. She is also thankful to Dr. C. Borreswar Rao for identifying the crystallographic axes, and to Dr. C. R. K. Murty for his interest in the work. The financial aid by the Department of Atomic Energy is gratefully acknowledged.

Magnetic Resonance Labs., G. PADMAVATHI,  
Physics Department,  
Andhra University,  
Waltair, March 15, 1968.

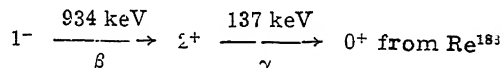
- Wyckoff, R. W. G., *Crystal Structures*, Vol. 3, Interscience Publishers, New York; Rausell Colom, J. A. and Garcia-Blanco, S., *Acta Cryst.* 1966, **21**, 672.
- Pake, G. E., *J. Chem. Phys.* 1948, **16**, 327.

## BETA-GAMMA DIRECTIONAL CORRELATION MEASUREMENTS IN <sup>170</sup>Tm AND <sup>186</sup>Re

The decay schemes<sup>1</sup> of the two isotopes, namely, Thulium-170 and Rhenium-186 are simple and well established. The following beta-gamma cascades in their decays are of present interest.



and



The angular correlation experiment was carried out with a fast-slow scintillation assembly.<sup>2,3</sup> The integral correlation experiments for the two cascades have yielded the angular correlation functions, given below:

$$^{170}\text{Tm}: W_{\beta-\gamma}(\theta) = 1 + (-0.09 \pm 0.006) P_2(\cos \theta) + (0.006 \pm 0.009) P_4(\cos \theta)$$

$$^{186}\text{Re}: W_{\beta-\gamma}(\theta) = 1 + (0.063 \pm 0.005) P_2(\cos \theta) + (-0.006 \pm 0.007) P_4(\cos \theta)$$

For both the cascades ε<sub>4</sub> values suggest that they are zero within experimental errors thus establishing the first forbidden nature of the respective beta transitions.

The differential correlation experiment was conducted for each of the beta-gamma cascades at two angles, namely, 90° and 180° and the beta-gamma anisotropy at each beta energy was estimated. The observed anisotropy in both the cases was large. The correlation coefficients (differential), ε<sub>2</sub>(w), were obtained from the observed anisotropies. All the usual corrections were applied and the final values of ε<sub>2</sub>(w) are summarized in Table I. These values are in agreement with those reported in Reference 4. From Table I, it is noted that the ε<sub>2</sub>(w) function shows a deviation from the ξ approximation<sup>5</sup> in both the cases.

TABLE I  
Differential correlation coefficients

Beta energy		<sup>170</sup> Tm Correlation coefficient $\epsilon_2 (\omega)$	<sup>186</sup> Re Correlation coefficient $\epsilon_2 (\omega)$
keV	mc <sup>2</sup> units		
227.5	1.445	-0.045±0.010	0.039±0.006
292.5	1.572	-0.051±0.010	0.040±0.006
357.5	1.699	-0.055±0.011	0.045±0.006
422.5	1.827	-0.062±0.011	0.048±0.006
487.5	1.954	-0.073±0.011	0.065±0.008
552.5	2.081	-0.089±0.012	0.059±0.009
617.5	2.208	-0.105±0.013	0.059±0.009
682.5	2.336	-0.090±0.013	0.074±0.010
747.5	2.463	-0.099±0.013	0.081±0.013

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1. Dzhelepov, B. S. and Ferker, L. K., *Decay Schemes of Radioactive Nuclei*, Pergamon Press, 1961.
2. Rao, W. V. S., Rao, V. S., Sastry, D. L. and Swami Jnanananda, *Phys. Rev.*, 1965, **140 B**, 1193.
3. —, — and —, *Proc. Phys. Soc.*, London, 1966, **87**, 917.
4. Dulaney, H., Braden, C. H., Patronis, E. T. Jr. and Wyly, L. D., *Phys. Rev.*, 1963, **129**, 283.
5. Kotani, T. and Ross, M., *Phys. Rev. Letters*, 1958, **1**, 140.

## PHYSICAL PROPERTIES OF CRYSTALS

It is well known that the character method<sup>1</sup> (Bhagavantam and Suryanarayana, 1949) could be successfully employed for deriving the number of independent constants in respect of the various physical properties for the 32 classes of crystals. Recently Bhagavantam and Pantulu<sup>2</sup> (1964) have used this method to obtain the number of non-vanishing independent constants for the galvano-magnetic, thermo-magnetic and piezogalvano-magnetic effects in single crystals. In this note it is proposed

to rederive the constants for the above effects by Jahn's method<sup>3</sup> (1949), also based on group theory, and to extend it further.

If  $V$  denotes the representation of an axial vector and if Tisza's notation<sup>4</sup> (1933) for the symmetrical product  $[V^2]$  of  $V$  with itself is employed, one can extend the method of Jahn to higher symmetrical powers of  $V$ . The appropriate form of the representation corresponding to each one of the 10 centrosymmetric physical properties studied by Bhagavantam and Pantulu<sup>2</sup> is given in Table I where  $D_n$  is a representation of dimension  $2L+1$  and is even with respect to inversion.

One may easily verify, for any positive integral value of  $n$ , that

$$[V^{2n}] = D_0 + D_2 + D_4 + \dots + D_{2n} (n \geq 0),$$

$$[V^{2n+1}] = D_1 + D_3 + D_5 + \dots + D_{2n+1} (n \geq 1)$$

In the case of any physical property represented, say, by  $V$  [ $V^2$ ],  $V^2$  [ $V^2$ ], [ $V$ ] [ $V^{2n+1}$ ], etc., one has to use the above relations and to split up the product representation so formed into a set of irreducible representations. Substituting the values of the reduced form of  $D_n$  given by Jahn<sup>3,5</sup> for the axial point groups and the point group  $\bar{4}3m$  respectively and using the results of Tisza<sup>4</sup> (1933) one can read off the number of independent constants, which is given by the number of times the total symmetric representation is contained in the appropriate representation, for each one of the 32 crystal classes in respect of the 10 studied physical properties. The results so obtained agree completely with those of Bhagavantam and Pantulu. The number of physical constants of an isotropic solid  $R_n$ <sup>6</sup> is given by the coefficient of  $D_0$  in the appropriate representation and is given in the last column of Table I. These numbers could also be obtained by the character method by

TABLE I

No.	Representation		No. of constants of an isotropic solid ( $R_n^I$ )
1	$[V^2]$	$D_0 + D_2$	1
2	$V^2$	$D_0 + D_1 + D_2$	1
3	$V^3$	$D_0 + 3D_1 + 2D_2 + D_3$	1
4	$[V^2]^2$	$2D_0 + D_1 + 3D_2 + D_3 + D_4$	2
5	$V^2$ [ $V^2$ ]	$2D_0 + 3D_1 + 4D_2 + 2D_3 + D_4$	2
6	$V$ [ $V^3$ ]	$D_0 + D_1 + 2D_2 + D_3 + D_4$	1
7	$[V^2]$ [ $V^4$ ]	$21D_0 + D_1 + 4D_2 + 2D_3 + 3D_4 + D_5 + D_6$	2
8	$V^2$ [ $V^3$ ]	$D_0 + 4D_1 + 4D_2 + 4D_3 + 2D_4 + D_5$	1
9	$V^2$ [ $V^4$ ]	$2D_0 + 3D_1 + 5D_2 + 4D_3 + 4D_4 + 2D_5 + D_6$	2
10	$[V^2]^3$	$5D_0 + 6D_1 + 11D_2 + 7D_3 + 6D_4 + 2D_5 + D_6$	5

using the formula<sup>6</sup> (Venkatarayudu and Krishnamurty, 1952):

$$n_i = \frac{1}{2\pi} \int_0^\pi (\chi_+ \chi_- + \chi_- \chi_+) d\phi,$$

where  $\chi_\pm$  is  $1 \pm \cos \phi$ , and  $\chi'_\pm$  stands for the character of the physical property under consideration.

The authors' thanks are due to Prof. T. Venkatarayudu for his kind interest in the work.

Andhra University, T. S. G. KRISHNAMURTY.  
Waltair, P. GOPALAKRISHNAMURTY.  
February 10, 1968.

1. Bhagavantam, S. and Suryanarayana, D., *Acta Cryst.*, 1949, 2, 21.
2. — and Pantulu, P. V., *Proc. Ind. Acad. Sci.*, 1964, 50, 1.
3. Jahn, H. A., *Acta Cryst.*, 1949, 2, 30.
4. Tisza, L., *Z. Physics*, 1933, 82, 48.
5. Jahn, H. A., *Proc. Roy. Soc. A*, 1938, 168, 469.
6. Venkatarayudu, T. and Krishnamurty, T. S. G., *Acta Cryst.*, 1952 5, 287.

## OXIDATION OF SOME ORGANIC COMPOUNDS BY COBALTIC ION

COBALTIC ion was shown to be a good oxidising agent<sup>1</sup> for types of compounds such as formic acid easily oxidisable to  $\text{CO}_2$ . In continuation of our previous communication,<sup>2a</sup> results of kinetics of oxidation of allyl alcohol, acetic acid, citric acid, glucose, tetrahydrofuran in sulphuric acid medium by cobaltic ion are now presented.

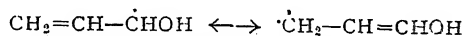
Allyl alcohol (M and B reagent), citric acid (E. Merck), acetic acid (fluka), glucose (BDH, AR) and tetrahydrofuran (Riedel) were used. Preparation of cobaltic sulphate was described earlier.<sup>2b</sup> The reaction was followed by studying the rate of cobaltic ion disappearance by iodimetry. Low temperature (5 to 15°C.), high  $[\text{H}^+]$  (2 M to 4 M) and [substrate] ( $10^{-3}$  to  $10^{-1}$  M) employed kept the

water oxidation to a minimum. Our experimental findings are: (i) The rate of cobaltic ion disappearance was found to be first order each with respect to  $[\text{Co}^{3+}]$  and [substrate] and the second order rate constant,  $k_2 = a + b/[\text{H}^+]$  ( $a \approx 10b$  in the case of citric acid and tetrahydrofuran and  $a \approx 2b$  or  $3b$  for the rest of the substrates). (ii)  $[\text{HSO}_4^-]$  and  $\mu$  (both 0.5 to 2 M) retarded the rate to the same extent (30% for allyl alcohol and tetrahydrofuran, 35% for glucose, 50% for citric acid and 70% for acetic acid). (iii) Added  $\text{Co}^{2+}$  (0 to  $10 \times 10^{-2}$  M) increased the rate ( $\sim 15$  to 30%) but the increase was strikingly greater in the case of citric acid (five-fold) so as to change the rate law into  $-\text{R}_{\text{Co}} = [\text{Co}^{3+}] [\text{citric acid}] \{k + k' [\text{Co}^{2+}]\}$ . (iv) Temperature dependence of the rate was found to be anti-Arrhenius (i.e.), the temperature coefficient of the reaction rate or rate constant was obtained for a difference of 5°C.

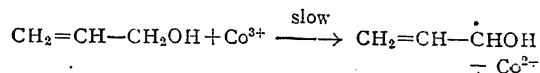
$$\left(\frac{k_{t+5}}{k_t} \approx 2 \text{ to } 3\right).$$

(Table I gives the values of  $\Delta E$ , A,  $\Delta S^\ddagger$ , etc. Magnitudes of A are of the same order as the one reported by Wells<sup>3</sup>).

We conclude that (i) oxidation of allyl alcohol > other alcohols<sup>4</sup> (the latter studied in  $\text{HClO}_4$  medium) may be attributed to the mesomeric effect stabilising the radical in the former,



and the reaction mechanism may be



where C-H bond fission was assumed as for allyl alcohol oxidation<sup>5</sup> by  $\text{V}^{5+}$  and chromic acid oxidation of substituted allyl alcohols.<sup>6</sup>

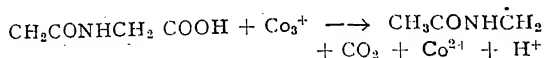
(ii) Citric acid oxidation rate < rates of oxidation of other hydroxyacids<sup>7</sup> may involve fission of either carboxyl hydrogen or hydroxyl

TABLE I

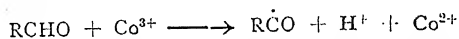
$[\text{Co}^{3+}] = 10^{-4}$  to  $10^{-3}$  M and [substrate] =  $10^{-3}$  to  $10^{-1}$  M

Substrate	$k_2 \times 10^2 \text{ l. m}^{-1} \text{ sec}^{-1}$			A $\text{l. m}^{-1} \text{ sec}^{-1}$	$\Delta E$ $\text{K cal. mole}^{-1}$	$\Delta S^\ddagger$ $\text{e.u. mole}^{-1}$	$[\text{H}_2\text{SO}_4]$ and $\mu$
	5°C.	10°C.	15°C.				
Allyl alcohol	9.232	22.52	48.62	$1.538 \times 10^{20}$	27.04	33.90	2MH <sup>+</sup> and 2.1μ
Acetic acid	3.572	8.42	20.84	$1.377 \times 10^{20}$	27.46	33.69	
Citric acid	4.750	10.00	21.93	$3.475 \times 10^{17}$	23.87	21.34	
Tetrahydrofuran	..	..	0.3175	$3.638 \times 10^{22}$	33.05	44.71	4MH <sup>+</sup> and 4.1μ
Glucose	7.060	16.94	40.00	$2.643 \times 10^{20}$	27.46	34.97	

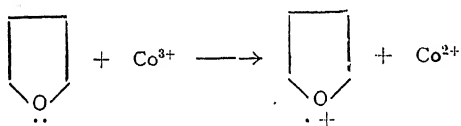
hydrogen. (iii) Aceturic acid (N-acetyl glycine) oxidation rate  $\approx$  citric acid oxidation rate. Glycine was attacked by  $\text{Co}^{3+}$  very slowly. The introduction of an acetyl group in the place of hydrogen (glycine and N-acetyl glycine) rendered the latter compound easily oxidisable and the plausible oxidative route may be



(iv) In glucose, aldehydic hydrogen may be involved in the rate-controlling step.



(v) A reaction mechanism corresponding to that of dioxane<sup>2a</sup> may be suggested for tetrahydrofuran:



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Madras-25, March 19, 1968.

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M. SANTAPPA.

1. Swann and Xanthakos, *J. Am. Chem. Soc.*, 1931, **53**, 403.
- 2 (a). Meenakshi, A. and Santappi, M., *Curr. Sci.*, 1968, p. 44.
- 2 (b). Jijie, K., Santappa, M. and Mahadevan, V., *J. Poly. Sci., A*, 1966 p. 378.
3. Wells, C. F., *Trans. Faraday Soc.*, 1967, **63**, 156.
4. Waters, W. A. and Littler, J., *Oxidn. Org. Chem.*, 1965, p. 216.
5. Jones, J. R. and Waters, W. A., *J. Chem. Soc.*, 1962, p. 2068.
6. Burstein, S. H. and Ringold, H. J., *J. Am. Chem. Soc.*, 1967, p. 4722.
7. Unpublished results in our laboratory.

### CO-ORDINATION COMPLEXES OF NIOBIUM (V) CHLORIDE ALKOXIDES WITH $\alpha$ - $\alpha'$ DIPYRIDYL

RECENTLY the co-ordination complexes of molybdenum (V) chloride alkoxides with dipyridyl have been reported by Anand, Multani and Jain.<sup>1</sup> These were prepared by the direct interaction of chloride alkoxides, of molybdenum with dipyridyl in alcohol medium as well as by the alcohol interchange method. Djordjovic and Katovic<sup>2</sup> have reported the preparation of simple and polymeric dipyridyl complexes of niobium and tantalum oxychloride alkoxides by the interaction of their chlorides with dipyridyl in aqueous alcohols.

The present investigation deals with the interaction of dipyridyl with niobium (V) chloride alkoxides under anhydrous conditions.

Niobium pentachloride has already been found to react with alcohols<sup>3</sup> forming chloride alkoxides of the general formula  $\text{NbCl}_2(\text{OR})_3$  where R = alkyl group like methyl, ethyl, isopropyl, *n*-propyl, *n*-butyl, etc. It has now been observed that the above chloride alkoxides form co-ordination complexes with dipyridyl having the general formula  $\text{NbCl}_2(\text{OR})_3 \cdot \text{dipy}$ . (dipy = dipyridyl) and even in presence of a large excess of dipyridyl, not more than one molecule of it is attached to niobium chloride alkoxides. The above complexes are readily obtained by the direct interaction of niobium chloride alkoxides with dipyridyl in alcohol.

To 1.6 g. niobium pentachloride 75 g. of ethyl alcohol was added and the solution refluxed for about four hours. After the addition of 1.0 g. of dipyridyl in 25 g. of ethyl alcohol, the refluxing was continued for about two hours and then the mixture evaporated to dryness under reduced pressure. The residue was thoroughly washed with ethyl alcohol and dried under reduced pressure. The pale yellow compound thus obtained was found to have the composition  $\text{NbCl}_2(\text{OEt})_3 \cdot \text{dipy}$ . (Found: Nb, 20.8; Cl, 15.3; OEt, 29.2; N, 5.8% Calc. for  $\text{NbCl}_2(\text{OEt})_3 \cdot \text{dipy}$ : Nb, 20.4; Cl, 15.5; OEt, 29.6; N, 6.1).

Requisite quantities of isopropyl, *n*-propyl and *n*-butyl alcohols were used in the preparation of corresponding dipyridyl complexes of niobium dichloride trialkoxides and their analyses were found to agree with the general formula  $\text{NbCl}_2(\text{OR})_3 \cdot \text{dipy}$ . Niobium and chloride were determined as niobium pentoxide and silver chloride respectively. Ethoxide was estimated by the chromic acid method.<sup>4,5</sup> In some cases the percentage of carbon was also found by combustion method.

Although Bradley and Bains<sup>6</sup> have reported the co-ordination complexes of aluminium, titanium, zirconium and tantalum alkoxides with ethylenediamine very few other metal alkoxides form such co-ordination complexes. However, chloride alkoxides of metals readily form similar complexes with alcohols,<sup>7</sup> esters,<sup>7</sup> ammonia,<sup>8</sup> amines<sup>8</sup> and dipyridyl.<sup>1</sup> The present investigation shows that niobium dichloride trialkoxides also readily form co-ordination complexes with dipyridyl thereby illustrating the enhanced tendency of metal alkoxides to



form co-ordination complexes when an electro-negative group is also attached to the metal.

The authors are thankful to Prof. T. R. Seshadri, F.R.S., for helpful discussions.

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1. Anand, S. K., Multani, R. K. and Jain, B. D., *Curr. Sci.*, 1967, **36**, 121.
2. Djordjovic, C. and Katovic, V., *Chem. Communications*, 1966, **8**, 224.
3. Parkash, S. and Kapoor, R. N., *Indian J. Chem.*, 1967, **5**, 50.
4. Adams, C. A. and Nicholls, J. R., *Analyst*, 1929, **54**, 2.
5. Bradley, D. C., Abdel Halim, F. M. and Wardlaw, W., *J. Chem. Soc.*, 1950, p. 3450.
6. Bains, M. S. and Bradley, D. C., *Canad. J. Chem.*, 1962, **40**, 2218.
7. Bradley, D. C., *Progr. Inorg. Chem.*, 1960, **2**, 303.
8. Gilman, H., *J. Am. Chem. Soc.*, 1956, **78**, 6027.

### POTENTIAL FUNGICIDES

IN view of the significant biological properties associated with 4-thiazolidones such as local anaesthetics,<sup>1</sup> amoebicidal agents,<sup>2</sup> anticonvulsants<sup>3</sup> and fungicides,<sup>4,5</sup> it was considered worthwhile to synthesise some 2-arylimino-3-aryl-4-thiazolidones, their azo and sulphone derivatives. 2-Arylimino-3-aryl-4-thiazolidones<sup>6</sup> were synthesised by condensing N, N'-disubstituted asymmetrical thioureas<sup>7</sup> with mono-

chloroacetic acid. 2-Arylimino-3-aryl-5-*p*-tolueneazo-4-thiazolidones were prepared by condensing the corresponding thiazolidones with *p*-toluenediazonium chloride as usual and 2-arylimino-3-aryl-4-thiazolidone sulphones were prepared by oxidation with  $\text{KMnO}_4$  in glacial acetic acid medium.

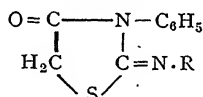
The structure of the compounds has been corroborated by studying the degradation products. Characteristic derivatives were also obtained.

The thiazolidones have been screened against the fungus *Helminthosporium euphorbiae* for their fungicidal activity. Practically all the compounds reported here have been found to be very good fungicides.

**2-Arylimino-3-Phenyl-*D*-Thiazolidones.**—These were prepared by condensing N-phenyl-N'-arylthioureas (0.1 mole) with monochloroacetic acid (0.11 mole) in the presence of anhydrous sodium acetate (0.2 mole) in absolute ethanol on a water-bath for 4-5 hours with occasional shaking. After the reaction was complete, the semi-solid mass was treated with hot water to remove the unreacted monochloroacetic acid and sodium acetate. The pasty mass became solid on treatment with ice-cold water. It was crystallised from ethanol.

The yields, melting points and analytical data of these thiazolidones are recorded in Table I.

TABLE I



Physical data and fungicidal activity of various 2-arylimino-3-phenyl-4-thiazolidones

2-Arylimino-3-phenyl-4-thiazolidones											Fungicidal activity*	
No.	Aryl group --R--	Yield %	M.P. °C.	Molecular formula	Nitrogen %		Sulphur %		5- <i>p</i> -tolueneazo deri- vative M.P. °C.	Sulphone derivative M.P. °C.	Concn. 0.1%	Concn. 0.2%
					Found <sub>y</sub>	Calc.	Found	Calc.			Linear growth in mm.	Linear growth in mm.
1	<i>o</i> -Tolyl-	65	144	C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> OS	9.75	9.93	11.40	11.34	147	107	37	10
2	<i>m</i> -Tolyl-	55	151	C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> OS	9.88	9.93	11.46	11.34	158	127	35	No growth
3	<i>p</i> -Tolyl-	70	112	C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> OS	9.64	9.93	11.52	11.34	152	163	18	"
4	<i>o</i> -Chlorophenyl-	50	143	C <sub>15</sub> H <sub>11</sub> N <sub>2</sub> OSCl	9.01	9.25	10.46	10.58	156	78d	14	"
5	<i>m</i> -Chlorophenyl-	60	137	C <sub>15</sub> H <sub>11</sub> N <sub>2</sub> OSCl	9.19	9.25	10.63	10.58	142	101	15	23
6	<i>o</i> -Anisyl-	68	154	C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub> S	9.30	9.39	10.71	10.74	110	194	22	18
7	<i>m</i> -Anisyl-	60	110	C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub> S	9.28	9.39	10.83	10.74	142	96	35	25
8	<i>p</i> -Anisyl-	50	193	C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub> S	9.16	9.39	10.86	10.74	..	..	30	14
9	$\alpha$ -Naphthyl-	65	120	C <sub>19</sub> H <sub>14</sub> N <sub>2</sub> OS	8.63	8.80	9.96	10.07	99	86d	25	12
10	$\beta$ -Naphthyl-	65	174	C <sub>19</sub> H <sub>14</sub> N <sub>2</sub> OS	8.52	8.80	10.15	10.07	147	170d	20	13

\* Control...60 mm.; Acetone control...57 mm.; Temp...25°C.

**Hydrolysis of Thiazolidones with Ethanolic HCl.**—A mixture of 2-o-tolylimino-3-phenyl-4-thiazolidone (2.0 g.), ethanol (15 ml.) and concentrated HCl (6 ml.) was refluxed on a water-bath for 5 to 6 hours. After distilling off ethanol, the reaction mixture was poured into cold water and then filtered. The residue was washed with water, dried, and crystallised from ethanol, m.p. 143° C.

(Found: N, 7.20; S, 16.53.  $C_9H_7NO_2S$  requires N, 7.25; S, 16.58%.)

The above data showed that the compound was 3-phenyl-2:4-thiazolidindione as the melting point remained undepressed on admixture with 3-phenyl-2:4-thiazolidindione.

The presence of o-toluidine in the filtrate has been confirmed by preparation of its hydrochloride and azo- $\beta$ -naphthol derivative. Likewise the position of aryl groups in various thiazolidones have been confirmed.

**2-Arylimino-3-Phenyl-5-p-Tolueneazo-4-Thiazolidones.**—A solution of 2-o-tolylimino-3-phenyl-4-thiazolidone (0.1 mole) in glacial acetic acid was slowly added at 0° C. to a solution of p-toluenediazonium chloride (0.1 mole) with stirring. The mixture was kept for an hour at 0–5° and the product was crystallised, after washing, from ethanol.

Similarly 5-p-tolueneazo derivatives of other thiazolidones were prepared as listed in Table I. Satisfactory nitrogen analyses were obtained for these compounds.

**2-Arylimino-3-Phenyl-4-Thiazolidone Sulphones.**—2-o-Tolylimino-3-phenyl-4-thiazolidone (0.003 mole) dissolved in glacial acetic acid (10 ml.) was treated slowly with  $KMnO_4$  (0.003 mole) dissolved in water (40 ml.) at 0° C. After completion of the reaction, excess of  $KMnO_4$  was removed by treatment with sodium bisulphite and the sulphone was filtered, washed, dried and then crystallised from alcohol.

Similarly other 2-arylimino-3-phenyl-4-thiazolidone sulphones were prepared. Their melting points are recorded in Table I. Satisfactory sulphur analyses were obtained for these compounds.

**Fungicidal Activity Screening.**—The method employed consists of testing the fungicide at varying grades of concentration with the growth of a test fungus, *Helminthosporium euphorbiae*, parasitic on *Euphorbia geniculata*.

The experiment was performed in petri dishes in which 20 ml. of sterilized Czapek agar medium was added. The fungicide was added to the medium after autoclaving. For

each concentration of fungicide three plates were prepared and the test fungus was inoculated in the centre. Plates were incubated at 25° C.  $\pm$  2 for a week. Two controls, one containing the above quantity of the medium only and another containing the same quantity of the medium and 0.5 ml. of acetone but without the fungicide, were also prepared to compare the observation. The diameter of colonies were recorded after the lapse of a week and is presented in Table I.

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Dept. of Chemistry, K. S. L. SRIVASTAVA.  
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1. Surrey, A. R., *J. Am. Chem. Soc.*, 1949, **71**, 3105 and 3354.
2. — and Cutler, R. A., *Ibid.*, 1954, **76**, 578.
3. Troutman, H. D. and Long, L. M., *Ibid.*, 1948, **70**, 3436.
4. Das, N. K., Mohapatra, G. N. and Rout, M. K., *Ibid.*, 1955, **77**, 2427; *J. Sci. & Ind. Res.*, 1955, **14 B**, 448.
5. Bhargava, P. N., Miss Bhargava, K. and Kapoor, R. C., *J. Indian Chem. Soc.*, 1961, **38**, 23.
6. Dains, F. B., Irvin, K. and Harrel, C. G., *J. Am. Chem. Soc.*, 1921, **43**, 613.
7. Fry, H. S., *Ibid.*, 1913, **35**, 1539.

**!CERCARIA MELANOCRUCIFERA, A NEW MAGNACERCOUS CERCARIA (OPISTHORCHIOIDEA) FROM THE MARINE GASTROPOD, TURRITELLA ATTENUATA REEVE, 1897, FROM THE BAY OF BENGAL, MADRAS**

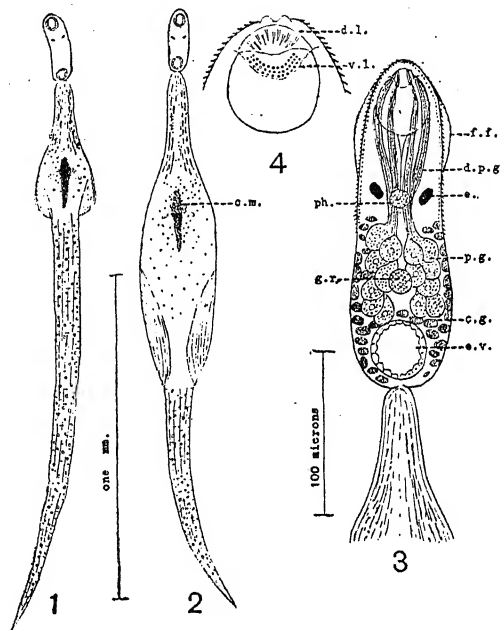
*Magnacercous cercariae* possessing enormously enlarged and distinctively pigmented tails, devoid of a finfold encountered in other opisthorchioid cercariae, have been reported only by a few workers. Four species of such cercariae; *C. caribbea* XVI-XIX were obtained from *Cerithium algicola*, *C. variabile*, and *Territella exoleata*, in Puerto Rico.<sup>1</sup> All cercariae of the Opisthorchioidea described up to 1960 were grouped together in a key,<sup>2</sup> which included *C. caribbea* XIV-XIX from Puerto Rico, and *C. purpuracaudata* Miller 1925, and *C. equitator* Sinitsin, 1911, from the Black Sea and Washington respectively. In the world list of marine cercariae,<sup>3</sup> thirteen species were mentioned as belonging to the family Heterophyidae Odhner 1914, and three of unknown affinity. Of the former group, seven species were

reported to have been assigned to the family by this writer himself (independent of the list by Dunagan<sup>2</sup>), and six others, *C. caribbea* XVI-XIX from Puerto Rico, *Cercaria komiya* and *Cercaria nigrocaudata* from brackish water hosts in Tokyo Bay.<sup>4</sup> *Cercaria caribbea* LXXI from *Cerithium variabile* in Jamaica was added to the known fauna by Cable.<sup>5</sup> No cercaria of this category or description has been reported from India yet.

This account of a magnacercous cercaria is based on a study of a large number of specimens obtained from the hepatopancreas of one of two hundred individuals of *Turritella attenuata* dredged from the shore in Madras and dissected for the purpose.

**Specific diagnosis.**—Magnacercous cercaria, of the Opisthorchioid Group, with proximal region of tail inflated a little behind the base and not abruptly enlarged; distal region slender and tapering to a point. The enlarged portion showed a variable shape, the commoner one as a short pear-shaped structure (Fig. 1) and the other longer and spindle-shaped (Fig. 2). Body 0.170–0.200 mm. long, widening behind the middle, and 0.060–0.080 mm. in maximum width. Tail 0.900–1.470 mm. long and 0.210 mm. in maximum width, with reddish-brown longitudinal pigmented streaks at the base, and a black cruciform marking in the dilated and vacuolated region, discernible more clearly in live specimens. The postero-lateral corners of the enlargement are equipped with muscle fibres in hemispherical patches. The small posterior part of the tail has a width of 0.051–0.110 mm. Oral sucker 0.022–0.032 mm. in diameter, eye spots dark and rectangular. Body spination (Fig. 3) confined to anterior half. A delicate narrow finfold present on each side in the anterior third of the body. Subterminal mouth; dorsal lip (Fig. 4) of oral sucker with two alternating rows of spines, and ventral lip with three rows of short spines in semi-circular arrangement; prepharynx narrow and straight, ending in globular embryonic pharynx, 0.007–0.0095 × 0.008–0.0115 mm.; rest of the digestive system not evident. Ventral sucker undeveloped. Penetration glands, seven on each side, posterior to eye spots; ducts in two bundles on each side, three in the outer and four in the inner, opening anterior to the mouth in crypts. Cystogenous glands, numerous filling the parenchyma behind the eye spots. Genital rudiment a mass of cells midway between pharynx and posterior end of the body. Excretory vesicle spherical 0.027–

0.034 mm. in diameter; ducts and flame cells not observed.



FIGS. 1–4. *Cercaria melanocrucifera* n.sp. Fig. 1. Entire, with pear-shaped inflation of tail. Fig. 2. Entire, fusiform inflation of tail. Fig. 3. Head, to show organization, especially fin-fold on body, penetration glands, cystogenous glands, spherical excretory vesicle, and spination. Fig. 4. Oral sucker, with dorsal and ventral lips bearing spines. c.g., cystogenous glands; c.m., cruciform marking; d.l., dorsal lip; d.p.g., ducts of penetration glands; e., eye; e.v., excretory vesicle; f.f., fin-fold; g.r., genital rudiment; p.g., penetration glands; ph., pharynx; v.l., ventral lip.

**Redia**, simple, with reddish-brown horizontal patches in the body, 0.620–1.180 mm. long and 0.125–0.190 mm. broad, sometimes swollen irregularly.

**Discussion.**—Species of *Turritella* have been known to harbour larval trematodes belonging to the Rhodometopa<sup>6,7</sup> and the Opisthorchioid<sup>1</sup> Groups. On a comparison with all the known magnacercous cercariae, the present one is found to resemble *C. caribbea* XVII Cable, 1956, to the greatest degree, but is distinctive in the presence of finfolds on the body and a black cruciform marking in the dilated region of the tail. It is accordingly designated as *Cercaria melanocrucifera* n.sp.

On the basis that "the excretory vesicle of the Galactosominae is sac-shaped or tubular, rounded anteriorly, without a suggestion of a bifurcation and, hence, more likely to be derived from the spherical vesicle possessed by the four species of magnacercous larvae than

from the vesicles of other types of opisthorchioid cercariæ, these larvæ were assigned to the sub-family Galactosominae, Heterophyidae. This relationship with the Heterophyidae has been adopted in the later studies of Cable and other workers.<sup>3-5,8,9</sup> Encysted metacercariæ of *Galactosomum spinetum* were obtained<sup>9</sup> from the visceral adipose tissue of the fish *Hyporhamphus unifasciatus* in Florida, following exposure to magnacercous cercariæ. From these morphological and experimental evidences, it has been suggested<sup>5</sup> that "adults of magnacercous larvæ probably are heterophyids which belong to the genus *Galactosomum* and are common parasites of shore birds". It is of interest that four species of *Galactosomum*, three of them as adults in the Sea Gull, *Larus argentatus*, and one as a juvenile in the crab, *Matuta victor*, have been described from the Madras Coast.<sup>10-11</sup> From an eco-geographical standpoint, the cercaria now described may be expected to be the larva of any of the above-mentioned species or a related one. The life-history of *Galactosomum* may, therefore, be understood to include a magnacercous cercaria from the gastropod encysting in fish and reaching maturity in ichthyophagous birds, occasionally utilizing a crab or other crustaceans as accessory or paratenic hosts.<sup>10</sup> Since the evidence for the identity of the magnacercous cercariæ with the Heterophyidae is nevertheless slender, experimental studies are needed for decisive taxonomic inferences.

This study was conducted at the University Zoology Laboratory, Madras, and the authors express their gratitude to its Director, Professor G. Krishnan, for facilities and advice. One of us (L. W. R.) is indebted to the Government of India, for the award of a scholarship under the Exchange Programme Scheme.

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niv. Zoology Lab., (MRS.) SITA ANANTARAMAN.  
Repauk, Madras-5,  
April 11, 1968.

1. Cable, R. M., *N.Y. Acad. Sci.*, 1956, **16**, 490.
2. Dunagan, T. T., *Proc. Helm. Soc. Wash.*, 1960, **27**, 44.
3. Holliman, R. B., *Tulane Studies Zool.*, 1961, **9**, 74.
4. Ito, J., *Jap. J. Med. Sci. and Biol.*, 1956, **9**, 235.
5. Cable, R. M., *Zeitschr. f. Parasit.*, 1963, **23**, 429.
6. Rothschild, M., *Parasitology*, 1935, **27**, 152.
7. Hutton, R. F., *J. Mar. Biol. Assoc.*, 1955, **34**, 249.
8. La Rue, C. R., *Exper. Parasit.*, 1957, **6**, 306.

9. Sogandares-Bernal, F. and Hutton, R. F., *Proc. Helm. Soc. Wash.*, 1960, **27**, 75.
10. Anantaraman, S., *Ph.D. Thesis (Zool.)*, University of Madras, 1961.
11. —, *J. Mar. Biol. Assoc. India*, 1963, **5**, 1.

#### A STUDY OF GROWTH RINGS IN OTOLITHS OF FISH BY MICRORADIOGRAPHY

OTOLITHS of fishes are used for the determination of their age by many conventional methods (Trout, 1958). Ehrenberg and White (1957), described microradiography and its uses in industrial radiography. An attempt is made here to study the growth rings in otoliths of fishes by microradiographic technique. This technique avoids the cumbersome procedures of grinding and polishing the otoliths for good resolution of rings. Otoliths of *Pomadasys hasta* (Bleeker), which forms a good trawl fishery along the Bombay coast, were taken for investigation.

Otoliths were washed in water and dried. The mounting of the sample was done in the dark room. They were placed at the centre of the lead frame over a black paper. A double-coated film "F" type, folded in a black paper was kept over it. Another black paper was placed on it so that the film remained in position over the specimen. This arrangement was made tight by keeping a lead sheet measuring 4" × 4" × 1" over it with an adjustable screw. The mounted specimen was placed on a stand 13 cm. away from the X-ray tube. The specimen was exposed to X-rays of 18 kV with 10 mA. current for 10 minutes. (35 kV X-rays with 60 mA. for 6 seconds gave result with less contrast and kV higher than 35 did not give satisfactory results). After the exposure, the film was removed to the dark room and developed. The negative was enlarged to the desired size.

The differential concentrations of the materials in the otoliths make a pattern of image on the radiographic plate according to the concentration in a particular area. When exposed to X-rays, there will be more absorption of X-rays in the opaque areas resulting in less incident radiation on the film and less darkening of the radiographic plate. In the hyaline areas (less dense) as there will be less absorption of the incident X-rays, more X-rays fall on the film making it more dark. As the plate is the positive of the radiograph, the hyaline areas are seen white and the opaque areas dark (Fig. 1, A). A photograph (Fig. 1 B) of the

same otolith is given for comparison to show the finer resolution of growth rings obtained by microradiography. The study of this pattern along with other methods like length frequency distribution will help to arrive at the correct determination of age in fishes which is an important aspect of fishery research.

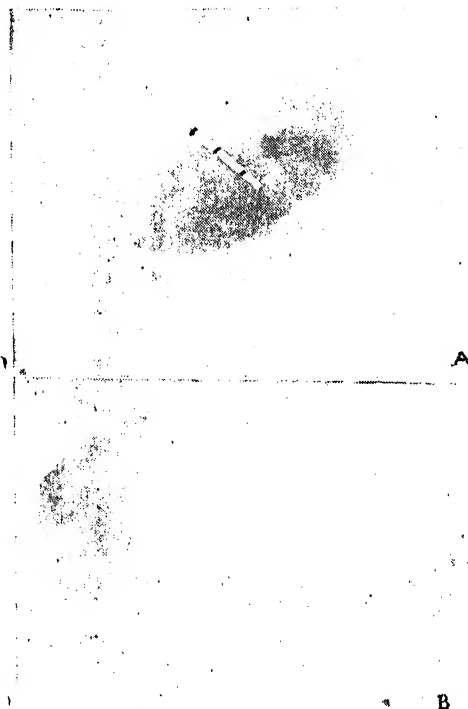


FIG. 1. A. Microradiograph of otolith showing the growth rings,  $\times 10$ . B. Photograph of otolith showing the growth rings,  $\times 10$ .

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1. Ehrenberg, W. and White, M., *Proceedings of the Symposium of the Cavendish Laboratory*, Cambridge, 1957.
2. Trout, G. C., *I.C.N.A.F.*, Special Publication, 1958 1, 207.

#### THE SATELLITED CHROMOSOMES OF *SPINACIA OLERACEA* LINN.

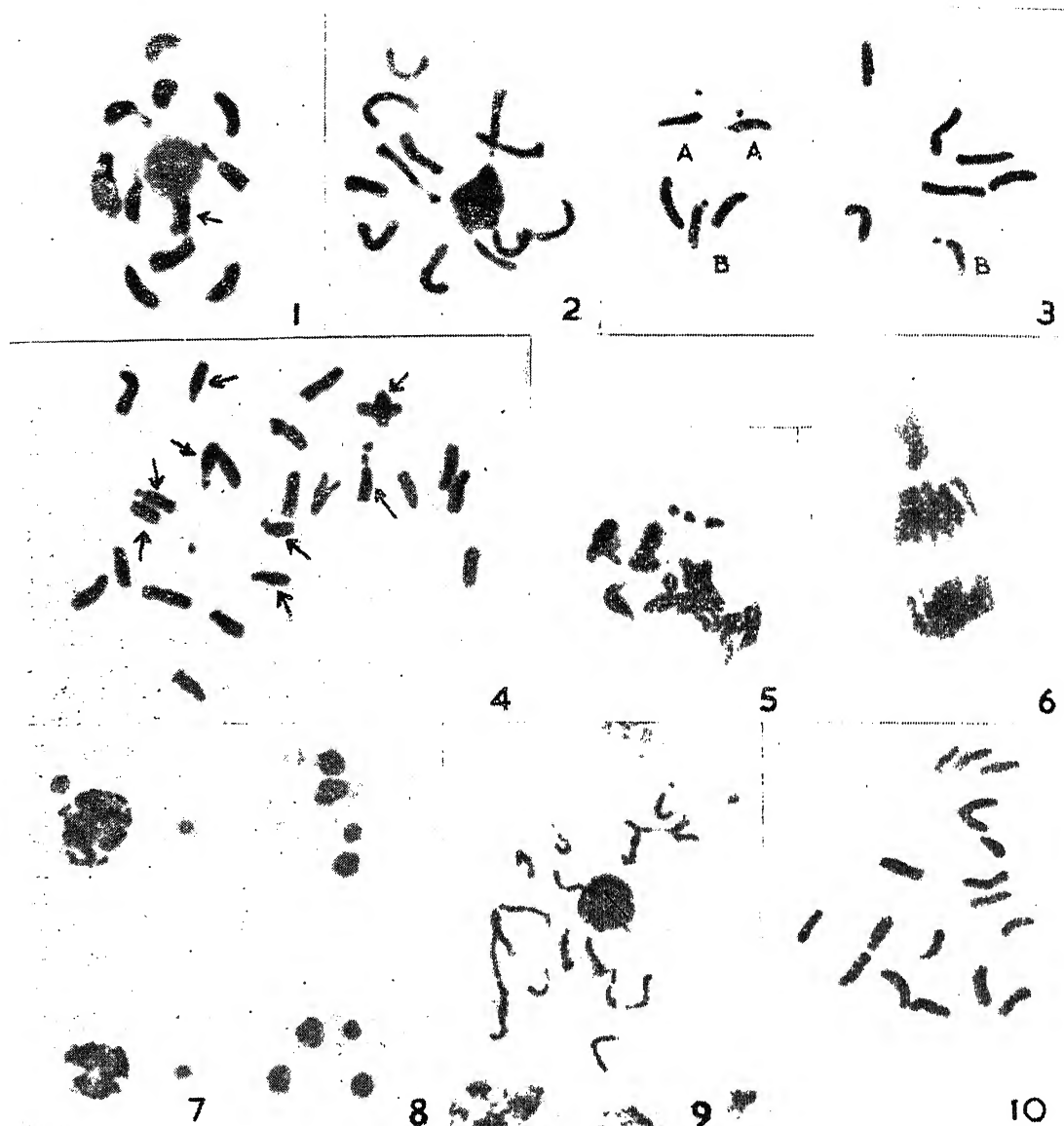
THE cytology of *Spinacia oleracea* Linn. has received considerable attention.<sup>1-3</sup> It is generally believed that a pair of SAT-chromosomes alone is present in its diploid complement. Confirmation is now offered for the solitary report of Hardh<sup>4</sup> in 1939 of the presence of another diploid karyotype having 4 SAT-chromosomes.

Of the two varieties of seeds obtained from M/s. Pocha and Sons, Poona, India, the germination of the "Bloomsdale" variety was found to be rather poor. This necessitated an entire dependence on the "prickly seeded" variety. The primary root-tips of the seedlings were fixed in acetic alcohol (1:3) for 24 hr., post-fixed in formaldehyde acetic alcohol (FAA—1:1:3) for 15 min. and were stored either in 70% alcohol or processed immediately as hæmatoxylin squashes.<sup>5</sup> The schedule followed was: hydrolysis in N HCl at 60° C. for 8 min., mordanting with 4% ferric ammonium sulphate for 25 min. and staining with a 0.5% solution of hæmatoxylin for 25-30 min. The stained material was washed repeatedly in distilled water, teased well in a drop of 45% acetic acid on a slide and then squashed.

To facilitate a scattering of the chromosomes, the root-tips were also treated with saturated solutions of  $\beta$ -dichlorobenzene, or  $\alpha$ -bromonaphthalene or with a 0.002M solution of 8-hydroxyquinoline for 30 to 90 minutes prior to fixation.

A late prophase is illustrated in Photo 1 where three of the SAT-chromosomes are lying around the nucleolus. The fibre and grain of the fourth SAT-chromosome (arrow in Photo 1) appears embedded in the nucleolar mass. In Photo 2, on the other hand, all the four SAT-chromosomes are attached to the nucleolus. The SAT-grains of two of them appear embedded in the nucleolar mass. Attention is invited to the strands of nucleolar matter connecting the nucleolus with two of the SAT-chromosomes.

The SAT-chromosomes appear to be of two types. The threads of one pair is long, while those of the other are short (A and B in Photo 3). In the tetrasomatic metaphase illustrated in Photo 4, 8 SAT-chromosomes could be recognized (arrows).



PHOTOS 1-10. Photos 1-6 and 10,  $\times$  ca. 1,500. Photos 7-9,  $\times$  ca. 700

Rare instances of the persistence of nucleoli at meta-, ana- and telo-phases were observed (Photos 5-7). Attention is invited to the 4 SAT-grains visible in the nucleolus in Photo 5. Four nucleoli were observed in the telophases of some of the meristematic cells (Photo 8).

Photos 9 and 10 are of pro- and meta-phases of a rare triploid root having 18 chromosomes. No polysomatic cells were observed. The triploid is interesting in that tetraploid or hexaploid seedlings have not been encountered so far in the specimens of *S. oleracea* investigated.

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1. Lorz, A. P., *Cytologia*, 1937, **8**, 241.
2. Berger, C. A., *Bot. Gaz.*, 1941, **102**, 759.
3. Iizuka, Muneco and Jules Janick, *Journ. of Heredity* 1966, **57**, 182
4. Hardh, H., *Maatalon ti. tieteiden Aikakauskirja (Helsinki)*, 1939, **11**, 317.
5. Marimuthu, K. M. and Subramaniam, M. K., *Curr. Sci.*, 1960, **29**, 482.
6. Gopinath, P. M. and Subramaniam, M. K., *Ibid.*, 1963, **32**, 169.

# EFFECT OF ASCOCHITINE ON THE IN VITRO GROWTH OF EMBRYOS OF *CLITORIA TERNATEA* L.\*

THE antibiotic ascochitine is a phytotoxic metabolite produced by *Ascochyta pisi* Lib.<sup>1</sup> and *A. fabae* Speg.<sup>2</sup> The physico-chemical nature of the toxin and its effects on the growth of bacteria and fungi and on seed germination were reported. From seed germination studies it was found that its toxicity was higher to roots than to coleoptiles.<sup>2</sup> Hence it was thought that a study of the effect of this toxin on decotylated embryos would lead to a better understanding of its influence on the germinating seed. The embryo of *Clitoria ternatea* was chosen for the present study. Ascochitine used in the present investigations was isolated from culture filtrates of *A. pisi* according to the procedure of Oku and Nakanishi.<sup>2</sup>

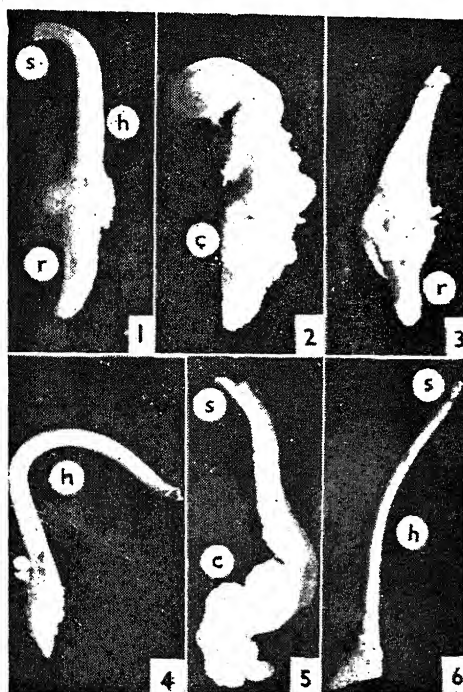
Embryos were dissected aseptically from fresh mature seeds. The cotyledons were removed and the embryonal axes were planted on 25 ml. of nutrient medium<sup>3</sup> in culture tubes of size 9" × 1". Cultures were maintained in a growth chamber at 24 ± 2° C. The cultures received 12 hours of fluorescent illumination per day. The total embryo length and observations on growth characteristics were recorded at intervals of 10 days. At least 15 replicates were maintained for each treatment.

All the cultures started growth on the fourth day after inoculation. Controls exhibited straight growth of root and hypocotyl whereas embryos grown on 5 ppm., 10 ppm. and 50 ppm of ascochitine initially started increasing in thickness and later exhibited curvatures of hypocotyl axes. Some specimens grown on 50 ppm. of ascochitine exhibited rupturing of the epidermis due to callusing of the cortex (Fig. 4). In all cases the hypocotyl turned green after a week's growth. However, the embryos exhibiting total callusing failed to turn green.

At low concentrations (5 ppm. and 10 ppm.) 60% of the embryos exhibited total callusing. The cortical parenchyma and apical meristems developed masses of white callus tissue (Fig. 2). In about 10% of the cultures, only the lower hypocotyl developed into callus. The upper hypocotyl elongated to a limited extent. Secondary root primordia were initiated in most of the callus tissue (Fig. 3). However, they failed to elongate and were inhibited. The shoot meristem was activated in about

20% of the cultures in which case the first foliage leaves expanded only after 60 days' growth.

In cultures grown on medium containing 50 ppm. of ascochitine a total inhibition of root meristem was observed (Figs. 4 and 6). The taproot meristem developed into a brownish mass of callus. Appearance of the hypocotyl was normal. Shoot buds were activated after 20 days' growth (Fig. 6). About 10% of the cultures exhibited total callusing but no secondary roots were initiated (Fig. 5).



FIGS. 1-6. Fig. 1. Control, after 20 days' growth, × 1-6. Fig. 2. Embryo grown on medium containing 5 ppm. ascochitine showing total callusing, × 3. Fig. 3. Embryo grown on medium containing 10 ppm. of ascochitine showing inhibition of root, the hypocotyl fails to elongate, × 4. Fig. 4. Growth of embryo on 50 ppm of ascochitine showing good elongation of hypocotyl and inhibition of root, × 3. Fig. 5. Embryo showing total callusing of hypocotyl on 50 ppm of ascochitine, × 1-2. Fig. 6. Embryo grown on 50 ppm. of ascochitine. The root primordium callused. Hypocotyl and shoot bud normal, × 2-5.

r, root; h, hypocotyl; s, shoot; c, callus.

Comparing the elongation of the hypocotyl in the embryos grown on 5, 10 and 50 ppm of ascochitine statistically there is no significant difference between the treatments.

In general the toxin exerts its effects on the embryos grown *in vitro* at much lower con-



centration than is required to cause perceptible effects on the germinating seed. The striking effect of ascochitine on embryo growth was the total inhibition of root growth although a low percentage of embryos exhibited total callusing of root apex and the hypocotyl. The shoot meristem, however, was not affected by the toxin at 5, 10 or 50 ppm. In a few cultures, the shoot meristem was observed to be activated among the callusing hypocotyl tissue after 60 days' growth.

This type of differential effect of ascochitine on the root and shoot meristem seems to indicate that the toxin is appreciably tissue specific. Comparing the effect of ascochitine with those of another tissue specific fungal toxin, namely fusaric acid, the latter inhibited shoot growth and caused wilting of shoot buds after a little growth, but had very little effect on root growth,<sup>4</sup> whereas ascochitine is more toxic to root meristem than to the shoot meristem.

The tissue specificity of ascochitine is probably due to differences in the qualitative nature of the root and the shoot proteins, since this toxin is known to combine with and denature proteins.<sup>5</sup> The root protein is perhaps more easily denatured by the toxin than that of the shoot. Alternatively, the shoot meristem presumably converts at least a good quantity of ascochitine to dihydroascochitine and thereby rendering it benign. This type of detoxication by biological reduction of ascochitine is known to be carried out by fungi insensitive to the toxin.<sup>5</sup> Further work is underway to elucidate the mechanism of action of ascochitine on the embryos grown *in vitro*.

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\* Memoir No. 43 from the Centre of Advanced Study in Botany.

1. Bertini, S., *Annali. Sperimentaz. Agraria*, (Roma), 1956, N.S. 11, 545.
2. Oku, H. and Nakanishi, T., *Phytopathology*, 1963, 53, 1321.
3. Linsmaier, E. M. and Skoog, F., *Physiol. Plantarum*, 1965, 18, 100.
4. Padmanabhan, D., *Curr. Sci.*, 1967, 36, 214.
5. Oku, H. and Nakanishi, T., *Phytopathol. Z.*, 1966, 55, 1.

### DETECTION OF MECHANICAL DAMAGE IN SOYA-BEAN (GLYCINE MAX) SEED BY RADIOGRAPHIC ANALYSIS

THE standard method used for the Soya-bean seed germination is to put the seed in moist sand (or between moist papers) and then subject it to alternating temperatures of 20-30°C. for 8 days. In cases of urgency quick testing methods are necessary. Of late, a quick testing method has been devised,<sup>1</sup> which may be termed as the 'radiographic analysis' of seeds. In this technique X-ray photographs (radiographs) of seeds reveal many information which could ultimately be used in assessing seed quality. It was shown that anatomical details of the seed samples give a clue to the potential viability in the case of fresh seed samples.<sup>1</sup> A positive correlation was found between the actual germination percentage and the anatomical potential calculated from the radiographs.<sup>2</sup>

Two fresh seed samples of Soya-bean, showing low percentage of germination and high percentage of abnormality were chosen for this study. The following radiographic method was followed: Voltage—15 kV; Current—2 mA; Distance—25 cm.; Exposure—3 sec.; Film—X-ray (rapid). The radiographs were analysed using an X-ray viewer fitted with a lens.

When the seed germination percentages of Soya-bean samples were assessed by the standard and radiographic methods, it was observed that in the case of sample A, the normal germination exhibited by standard method was 51%, whereas, the rest were abnormal and dead (Table I). The X-ray method showed about 57% normal and sound seed (which indicates potential seed germination) and the remaining 43% seeds had damages of various kinds in them. In a majority of cases, small cracks were found to occur in the hypocotyl region or in the radicle (Fig. 1). At times even the cotyledons were damaged. Though there is a difference of 6% in the estimates of normal germination between the two methods, they come within tolerance limits (cf. ISTA Rules, 1966, Table 13 b).<sup>3</sup> The sample B showed 39% normal germination by standard method and 47% by radiography method (Table I) and they also come under tolerance limits for seed testing purposes. Thus, the radiography method may be used practically for predicting seed viability in fresh soya-bean



seed lots in a very short time. One more advantage of this method is that, the same set of seeds could be actually germinated after the completion of radiographic analysis, as no damage is done to the seed during the process.<sup>4</sup>

It may be concluded from the foregoing, that radiographic method of estimating germination percentage in fresh soya-bean seed samples, is quite useful as it provides reliable data in a very short time.

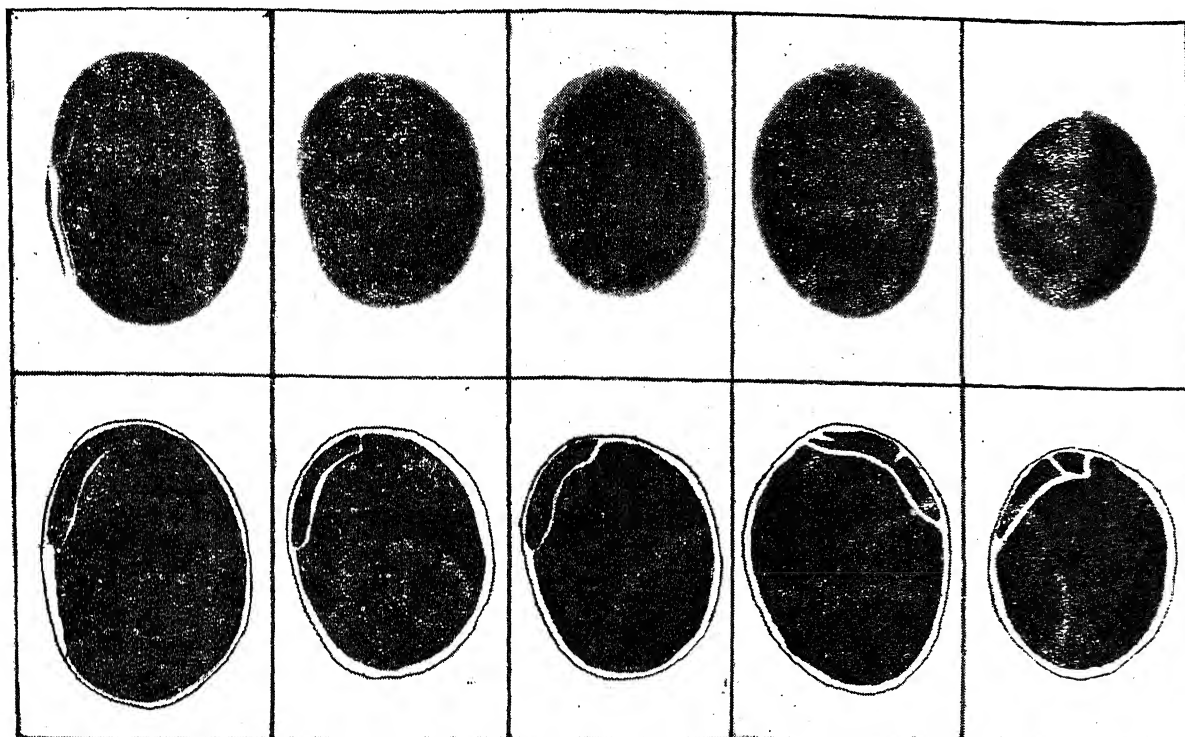


FIG. 1. Various kinds of mechanical damages in soya-bean seeds (enlarged).

The fact that this rapid method gives a little higher percentage of germination may be explained on the basis that some of the normal and sound-looking seeds sometimes lose viability during seed processing or storage. A modified radiographic method known as 'X-ray contrast method' was developed<sup>2</sup> which may be used to ascertain the viability even in older seeds more accurately.

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TABLE I  
Estimation of seed germination in soya-bean

Seed sample	Standard method			Radiography method	
	Normal germination	Abnormal	Dead	Sound seeds	Damaged seeds
A	51%	14%	35%	57%	43%
B	39%	49%	12%	47%	53%

1. Simak, M. and Gustafsson, A., *Hereditas*, 1953, **39**, 458.
2. —, *Medd. f Stat. Skogaforsk. Instt.*, 1957, **47** (1) 1.
3. International rules for seed testing, *Proc. Intern. Seed. Test. Ass.*, 1966, **31**, 1.
4. Kamra, S. K. and Simak, M., *Bot. Notis:r*, 1965 **118**, 254.

# **SOME ASPECTS OF EMBRYOLOGY IN *CYPERUS ALOPECUROIDES* ROTTB.**

THE family Cyperaceæ has attracted the attention of botanists especially due to the unique mode of pollen development. Elfving<sup>1</sup> (1879) was the first to study the development of pollen in Cyperaceæ. Since then several papers have appeared on different aspects of embryology in this family [cf., Juel<sup>2</sup> (1900), Tanaka<sup>10</sup> (1941), Shah<sup>8,9</sup> (1962, 1965), Khanna<sup>4</sup> (1965), Murthy and Kumar<sup>6</sup> (1967)]. However, the embryological work is inadequate to draw any generalizations such as raising of the subfamilies into a status of families. The present article deals with microsporogenesis, megasporogenesis, and the development of the male and female gametophytes, endosperm and the embryo in *Cyperus alopecuroides* Rottb.

*Cyperus alopecuroides* is a stout, perennial, aquatic herb, measuring upto 4 feet in height. Inflorescence, a large compound umbel, consists of primary and secondary rays. The latter end in clusters of spikelets. Each spikelet is composed of 10-15 distichously arranged glumes with minute naked bisexual flowers in the axils.

In transverse section a young anther is four-lobed. A single hypodermal archesporial cell, as seen in cross-section, is differentiated in each lobe. The archesporial cell divides periclinally to form an inner primary sporogenous cell and an outer primary parietal cell (Fig. 1). The primary parietal layer forms an endothecium, a middle layer and a glandular tapetum (Fig. 2). Thus the anther wall consists of four layers including the epidermis. The endothecium develops characteristic fibrous thickenings (Fig. 7). The tapetal cells remain uninucleate throughout. As the anther development proceeds the middle layer is crushed due to the enlargement of the outer endothelial cells and the inner tapetal cells. Some of the epidermal cells become enlarged and filled with tannin-like substances (Fig. 2).

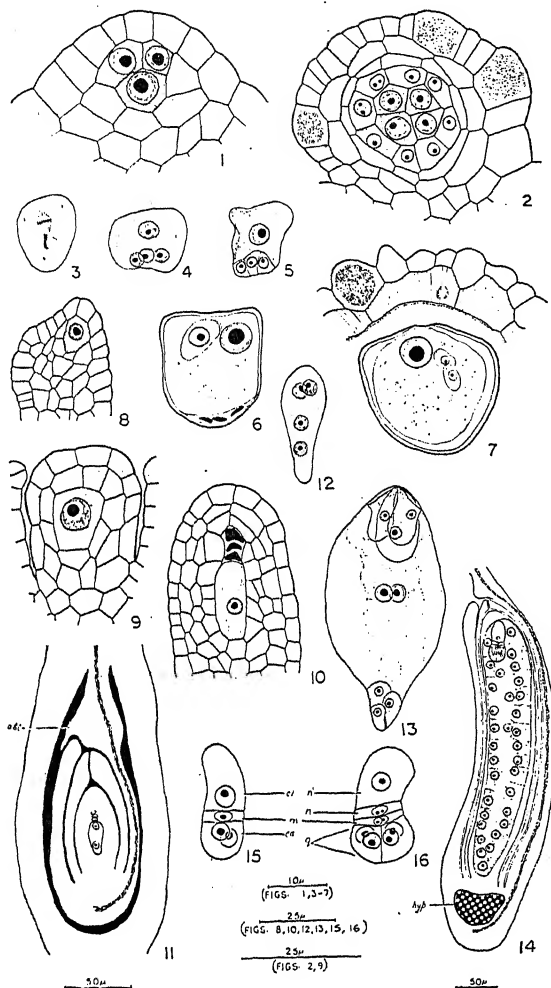
The primary sporogenous cell divides repeatedly and products of the last division are the microspore mother cells which undergo meiosis. The four nuclei formed after meiosis take an excentric position near the inner end of the microspore mother cell. One of the four nuclei increases in size and moves towards the center of the microspore mother cell while the other three remain small and degenerate later (Figs. 3-6). A delayed

simultaneous type of cytokinesis results in the formation of a hyaline thin cell wall separating the functional nucleus from the non-functional nuclei and similar walls separate the latter from each other (Fig. 5). The pollen grains have relatively thin exine and thick intine as in other members of the family, and are pear-shaped each with an ulceroid aperture at its distal end. They accumulate large amount of nutrients which sometimes mask the male cells and are shed at the three-celled stage (Fig. 7).

The ovary is superior, two- or three-carpellate, syncarpous and unilocular with one basal, anatropous, bitegmic and crassinucellar ovule. Some of the funicular epidermal cells near the micropyle elongate and function as an obturator (Fig. 11).

Usually a single hypodermal archesporial cell is differentiated in the nucellus at the beginning of curvature of the ovule (Fig. 8); rarely two archesporial cells are seen, but only one functions further. The archesporial cell divides periclinally forming an outer primary parietal cell and an inner sporogenous cell. The former by anticlinal and periclinal divisions forms two- or three-layered parietal tissue while the latter enlarges and directly functions as the megaspore mother cell. The megaspore mother cell undergoes meiosis to form a linear tetrad of megaspores (Figs. 9 and 10). Occasionally a T-shaped tetrad of megaspores is formed. The chalazal megaspore functions (Fig. 10) and its nucleus undergoes three successive divisions to form an eight-nucleate embryo sac which conforms to the Polygonum Type of development (Figs. 10-13) (Maheshwari, 1950).<sup>5</sup> The mature embryo sac is broad in the centre and narrow at the chalazal end. The egg apparatus consists of a large egg with a conspicuous nucleus at its apical portion and the vacuole at the basal region while the two hooked synergids have apical vacuoles with a filiform apparatus. The two polar nuclei fuse in the center of the embryo sac to form the secondary nucleus and the three antipodal cells occupy the narrow chalazal end of the embryo sac (Fig. 13).

Fertilization is porogamous. After fertilization the synergids and the antipodal cells degenerate. The first division of the primary endosperm nucleus is not followed by wall formation. Free nuclear divisions continue until about hundred nuclei are produced. Some of them aggregate at the chalazal end



FIGS. 1-16. Fig. 1. T. S. A portion of young anther showing the primary sporogenous cell and two parietal cells: Fig. 2. T. S. of a microsporangium showing sporogenous tissue and anther wall. Fig. 3. Metaphase II in the microspore mother cell. Fig. 4. Microspore mother cell showing four free nuclei. Fig. 5. A microspore tetrad. Fig. 6. Two-celled pollen grain. Fig. 7. T. S. A portion of a mature anther showing epidermis, fibrous endothecium and a 3-celled pollen grain. Fig. 8. Young ovular primordium showing an archesporial cell. Fig. 9. Megaspore mother cell. Fig. 10. Linear tetrad showing the chalazal functional megaspore and three degenerating ones. Fig. 11. L. S. of the basal portion of the ovary. Fig. 12. Four-nucleate embryo sac. Fig. 13. Eight-nucleate embryo sac. Fig. 14. L. S. of the ovule showing the developing embryo and centripetal wall formation in the endosperm. Fig. 15. Proembryonal tetrad. Fig. 16. Quadrant stage of the embryo. (*obt*, obturator; *hyp*, hypostase; *ca*, terminal cell of a two-celled proembryo; *m*, intermediate cell of the tetrad; *α*, basal cell of the proembryonal tetrad; *q*, quadrant; *n* & *n'*, upper and lower daughter cells of *α*).

and some around the proembryo while the rest occupy a peripheral position. Subsequently centripetal wall formation takes place and it is initiated at the octant stage of the proembryo (Fig. 14) and ultimately the entire endosperm becomes cellular. Thus the development of the endosperm corresponds to Nuclear Type. Simultaneously with these post-fertilization changes in the ovule, a group of nucellar cells at the chalazal region just above the funicular vascular supply becomes cutinized to form the hypostase (Fig. 14).

The zygote divides transversely to form an apical cell *ca* and the basal cell *cb*. The former undergoes two vertical divisions at right angles to each other to form the quadrant *q* while the latter undergoes transverse division results in two superposed unequal cells *m* and *ci* (Figs. 15 and 16). The cells of the quadrant divide by oblique walls which delimit a dermatogen from an inner group of cells (Fig. 14). The cell *m* functions as the initial of the radicular portion of the mature embryo while the octant gives rise to the cotyledon and the plumule. Thus the embryo development corresponds to the *Juncus* variation of the Onagrad type (Johansen,<sup>2</sup> 1950). The disposition of the embryonal organs in the mature embryo follows the 'Cyperus' type.<sup>3</sup>

Department of Botany, M. NAGARAJ.  
Central College, B. H. M. NIJALINGAPPA.  
Bangalore-1 (India),  
March 11, 1968.

1. Elfving, F., *Jena. Z. Naturw.*, 1879, 13, 1.
2. Juel, H. O., *Jb. wiss. Bot.*, 1900, 35, 626.
3. Johansen, D. A., *Plant Embryology*, Waltham Mass, U.S.A., 1950.
4. Khanna, P., *Can. J. Botany*, 1965, 43, 1539.
5. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, New York, 1950.
6. Murthy, Y. S. and Kumar, V., *Proc. Ind. Acad. Sci.*, 1967, 65 B, 185.
7. Schnarf, K., *Vergleichende Embryologie der Angiospermen*, Berlin, 1931.
8. Shah, C. K., *Plant Embryology—A Symposium*, C.S.I.R., New Delhi, 1962.
9. —, *Phytomorphology*, 1965, 15, 1.
10. Tanaka, N., *Bot. Mag.*, Tokyo, 1941, 55, 55.

# HILL REACTION ACTIVITY OF CYCAS LEAF CHLOROPLASTS

ALTHOUGH considerable work has been carried out on photosynthesis of higher plants and algæ, knowledge on the photosynthesis of gymnosperms, particularly Hill reaction, is relatively meagre. Decker<sup>1</sup> found that the photosynthetic rate in *Pinus sylvestris* seedlings increased linearly upto 6400 ft.c. whereas Freeland<sup>2</sup> observed that rates of photosynthesis vary in different age needles with a maximum rate after needle expansion in the first year. Jagendorf and Evans<sup>3</sup> observed low activity in the chloroplasts isolated from lower groups and found no considerable changes even with the improved methods of grinding procedure. The present study is of considerable interest, for the members of the lower groups exhibit certain unique features when compared with angiosperms in being green for most of the life. Hill reaction activity of chloroplasts isolated from 2 species of *Cycas* was compared with that of lower groups.

One-year old green leaves of *Cycas beddomei* Dyer. and *Cycas circinalis* L. were collected from the botanical garden and the material was pre-cooled for about 90 minutes before experimentation. About 10.0 g. of the leaf material was used after discarding the petioles for the extraction and fractionation of chloroplasts with sucrose phosphate buffer (pH 7.3) as per the method of James and Das.<sup>4</sup> Hill reaction activity of the chloroplast preparation was estimated according to the principle outlined by Jagendorf and Evans<sup>3</sup> using 2, 6-dichlorophenol indophenol as a redox dye. Chlorophyll content was estimated by the method of Arnon.<sup>5</sup> For the determination of Hill reaction, colorimeter tubes were prepared in the dark with reaction mixture.<sup>6</sup> Hill reaction activity of chloroplast was estimated as the decrease in optical density after exposure to light (2,000 Lux) at 15° C. for 3 minutes against the reagent blank using a spectronic-20 photoelectric colorimeter at 620 mμ with red filter. The decrease in optical density was calculated for mg. chlorophyll of the chloroplast suspension and was expressed as the decrease in optical density per mg. chlorophyll. The results are shown in Table I.

Chloroplasts isolated from the leaves of both the species possess photosynthetic mechanism qualitatively similar to lower groups but exhibited a fairly high activity. When expressed on unit chlorophyll bases the iso-

lated chloroplasts showed considerably more activity than those isolated from lower groups. Relative rates of Hill reaction activity in *Cycas* with other groups as studied by Jagendorf and Evans<sup>3</sup> is shown in Table II.

TABLE I

Hill reaction activity of chloroplasts isolated from leaves of *Cycas beddomei* Dyer. and *Cycas circinalis* L. as measured by changes in optical density (O.D.)

Plants used	Decrease in O.D.	Decrease in O.D./mg. chlorophyll
<i>Cycas beddomei</i> Dyer.	0.18	14.8
<i>Cycas circinalis</i> L.	0.22	13.7

TABLE II

Relative rates of Hill reaction activity in different plants

Plants used	Hill reaction rates units/mg. chlorophyll
* <i>Fellea</i> sp.	3.0
* <i>Adiantum pedatum</i>	3.9
* <i>Polypodium virginicum</i>	2.0
<i>Cycas beddomei</i> Dyer.	14.8
<i>Cycas circinalis</i> L.	13.7

\* Plants used by Jagendorf and Evans.

The authors thank Dr. I. M. Rao for encouragement.

Department of Botany, K. R. RAO.  
S.V. University, K. V. R. RAMANA.  
Tirupati (A.P.), N. M. KONDAIAH.  
March 9, 1968.

1. Decker, J. P., *Plant Physiol.*, 1954, **29**, 305.
2. Freeland, R. O., *Ibid.*, 1952, **27**, 685.
3. Jagendorf, A. T. and Evans, M., *Ibid.*, 1957, **32**, 435.
4. James, W. O. and Das, V. S. R., *New Phytol.*, 1957, **56**, 325.
5. Arnon, D. I., *Plant Physiol.*, 1949, **24**, 1.
6. Das, V. S. R. and Reddy, M. S., *Curr. Sci.*, 1967, **36**, 272.

## PARTHENIUM WEED IN MADHYA PRADESH

In an earlier communication,<sup>1</sup> I had dealt with the occurrence of *Parthenium hysterophorus* Linn. (Fig. 1) in the region of Delhi. This exotic weed belonging to the family Compositae was first noted in the neighbourhood of Poona in 1956 in the form of stray plants on rubbish heaps. By 1962 it had become numerically the most abundant plant in the whole of Poona along roadsides, in wastelands, by the sides of canals, railway lines, etc. The weed had also by then reached Kirkee station,

about 7 to 8 km. toward Bombay along the main S.-E. line of the Central Railways (See Maheshwari,<sup>1</sup> Santapau<sup>2,3</sup>). In 1963 the weed

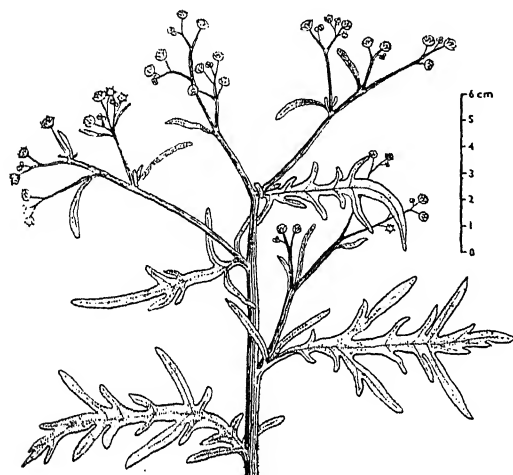


FIG. 1. *Parthenium hysterophorus* Linn.: Flowering twig.

found its way to Kashmir (Jammu) from Poona together with some rooted cuttings of jasmynes (See Hakoo<sup>4</sup>). During the course of botanizing in Delhi in 1964, I noted stray plants growing near settlements on the outskirts of Delhi. A second visit to the settlements in October 1965 showed a very high numerical increase of the plant, especially in the construction plots (See Maheshwari<sup>5</sup>). Recent study of the material collected from Itarsi, Madhya Pradesh, showed that the weed has made further ingress in the central parts of the country. A specimen of the weed obtained through the courtesy of Shri S. D. N. Tiwari, Conservator of Forests, Working Scheme Circle, Rewa, M.P., has been conserved in the Herbarium of National Botanic Gardens, Lucknow (Hardboard Factory, Itarsi, M.P., on black cotton soil, in open situations, S.D.N. Tiwari No. 20133, October 31, 1966, Herb. LWG). In a personal communication to the author, Shri Tiwari writes as follows: This species was collected in October 1966 from the premises of the Central Plywood and Hardboard Factory, Itarsi. The species has not been noted earlier in any part of the State. It appears that the plant has come as a weed from other provinces. Lot of material, especially the timber piles are imported from Dandeli; about 500 km. from Poona. A few employees are also working from Dandeli

where one of the branches of the factory is situated. So far, its spread on a large scale has not been observed in the State.

The weed is an adventive from tropical America. It has been reported from the West Indies and some parts of South Africa. Lately, it was found on the ore piles stocked at Canton, Port of Baltimore, Maryland and Newport News, Virginia in Eastern United States (See Reed<sup>6</sup>). In India the weed may be classed as a neophyte that has been unintentionally introduced by man. Further, it appears to be a component of the native ruderal vegetation, reproducing and spreading much like the indigenous species. The future existence of the weed in a new locality is also independent of man (See Thellung<sup>7</sup>).

A study of the distribution and numerical increase of the weed in the country should be of interest to the practising dermatologists. In India, dermatoses caused by plants (phyto-dermatoses) are commonly encountered in the practice of dermatology (See Behl<sup>8</sup>). In Texas, U.S.A., parthenium weed has already become notorious for its role in contact dermatitis. Shelmire<sup>9</sup> had examined a series of 56 weeds for their contact dermatitis by patch-testing their oleo-resins. In tests where poison ivy (*Rhus toxicodendron* Linn.) was used as a standard in the patch tests, the top seven plants (including poison ivy) were *Helenium tenuifolium* Nutt., *Iva angustifolia* Nutt. ex DC., *Parthenium hysterophorus* Linn., *Xanthium speciosum* Kearney, *Helenium microcephalum* DC., and *Ambrosia elatior* Linn. This note adds a new station for an adventive plant that may in time become dangerous or at least turn into a great nuisance in the country.

The author thanks Dr. L. B. Singh, Director, for interest in this study.

Floristic Botany Div., J. K. MAHESHWARI,  
National Botanic Gardens,  
Lucknow-1, March 7, 1968.

1. Maheshwari, J. K., *Curr. Sci.*, 1966, **35**, 181.
2. Santapau, H., *Indian Fmg.*, 1964, **14**, 23.
3. —, *The Flora of Khandala* (Ed. 3, revised), 1967, **16**, 329.
4. Hakoo, M. L., *Curr. Sci.*, 1963, **32**, 273.
5. Maheshwari, J. K., *Illustrations to the Flora of Delhi*, New Delhi, 1966, p. 17.
6. Reed, C. F., *Phytologia*, 1964, **10**, 338.
7. Thellung, A., *Mém. Soc. Nat. Sci. Cherbourg*, 1911-12, **38**, 57.
8. Behl, P. N., et al., *Skin-Irritant and Sensitizing Plants Found in India*, New Delhi, 1966 p. 1.
9. Shelmire, B., *J. Amer. Med. Ass.*, 1939, **113**, 1085.

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## REVIEWS AND NOTICES OF BOOKS

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### Scientific Method in Analysis of Sediments.

By John C. Griffiths. (McGraw-Hill Book Company, New York), 1967. Pp. 508. Price \$ 17.50.

This book deals with scientific methods and problem-solving in geology, using certain kinds of analysis of sediments and sedimentary rocks as illustrative examples of analytical procedures. The philosophy of method in analysis, data-gathering techniques, and data analysis (statistics) are covered.

The philosophy of method is integrated with data-gathering techniques and statistical analysis in the geo-sciences, with specific reference to the field of sedimentary petrography.

The material on sampling is the only detailed treatment of this essential subject. It includes discussion on sampling generally, a model for sampling sediments, and a critical review of present practice.

Scientific Method in Analysis of Sediments supplies an analytical model which leads to unique decisions on the data-gathering technique most suitable for a specified purpose, describes analysis of detrital sediments, and includes much new information on the petrography of detrital sediments.

The defining equation represents the inter-relationships among the fundamental properties of aggregates and may be used as a basis for mathematical formulation of many problems dealing with their constitution and behaviour.

Measurement scales determine the information level of the collected data and therefore indicate what type of statistical analysis may be performed.

The book may be "generalized" for the analysis of chemical sediments, ceramic bodies, and virtually any aggregate of elements.

This is an advanced text or reference book for the following courses: Sedimentary Petrographic Analysis, Sedimentology, Scientific Method in Geology, and Statistical Techniques in Geology. It is also a reference manual for any laboratory technician performing analysis of aggregates, including soils, artificial aggregates, etc.

Underwater Acoustics (Vol. I). Edited by V. M. Albers. (Plenum Press, New York), Pp. xiii + 354. Price \$ 12.50.

This book represents a compilation of the lectures presented at the Institute on Underwater Acoustics held at the Department of Physics of The Imperial College of Science and Technology of The University of London between July 31 and August 11, 1961. The institute was conducted by the Continuing Education Services of The Pennsylvania State University under a grant from the Scientific Affairs Division of the North Atlantic Treaty Organization.

At the institute, eighteen papers were presented by seventeen outstanding scientists in the field of Underwater Acoustics. This volume contains them and their titles are as follows: The Scientific Program Sponsored by NATO; Transducers; Sonar Arrays, Systems, and Displays; Explosive Sources; The Improvement of Vibration Isolation; A Sing-Around Velocimeter for Measuring the Speed of Sound in the Sea; Underwater Sound Calibration Stations at Le Brusc Laboratoire; Some Areas in which Underwater Acoustics Research is Needed; Internal Waves; High-Intensity Sound in Liquids; Scale Model Study of Propagation in Shallow Seas; A Visual Method of Representation of Low-Intensity Sound Fields; Non-specular Scattering of Underwater Sound by the Sea Surface; Thermal Microstructure in the Sea Surface; Thermal Microstructure in the Sea and its Contribution to Sound Level Fluctuations; Ambient Noise in the Sea and its Measurement; Flow Noise, Theory and Experiment; Some Contributions from Aeronautics to the Field of Underwater Noise; Underwater Acoustics as a Tool in Oceanography; Some Experiments on the Reduction of Structure-Borne Noise; and Signal Processing of Underwater Acoustic Fields.

This volume will be found useful by researchers in ultrasonics, oceanography, underwater acoustics, and undersea warfare.

**Mathematical Logic.** By Joseph R. Shoenfield. (Addison-Wesley Publishing Co., London), 1967. Pp. vii + 344. Price \$12.75.

Intended principally for graduate students in mathematics, this book constitutes an introduction to major topics in mathematical logic. The author has attempted to collect the principal results of what he feels to be the central topics: proof theory, model theory, recursion theory, and axiomatic number and set theory. The number of results is greatly increased by the problems. A knowledge of the simplest properties of natural numbers, real numbers, and sets, and a slight acquaintance with modern algebra should be sufficient background for an understanding of the material in this book. C. V. R.

**Linear Algebra and Analysis.** By Lichnerowicz. (Holden-Day, Inc., 500 Sansome Street, San Francisco), 1968. Pp. xv + 304. Price \$11.75.

This book, translated from a distinguished French series of mathematical works for physicists represents a unified treatment of linear algebra and linear analysis consistent with CUPM recommendations. Written on a relatively elementary level, it presents the great mathematical techniques of modern physics, yet always with the rigor essential to both mathematics and physics. The book attempts to familiarize the reader not only with the algebra of linear operators and matrices, but with tensor algebra as well. Linear analysis is covered in the second part, including the calculus of functions of several variables, exterior forms, series, linear functionals, and integral equations.

The book is suitable for advanced calculus at the upper division level or a second course in calculus to follow a strong first year in calculus of one variable. Of particular interest to physicists and engineers, it will also be useful to the great mathematician who wishes to update his knowledge of analysis. C. V. R.

**Differential Operators of Mathematical Physics.** By Guntner Hellwig. (Addison-Wesley Publishing, Co., Inc., West End House, 11, Hills Place, London, W. 1), 1967. Pp. 296. Price Rs. 100.00.

The book gives an introduction to the field of differential operators in Hilbert space. A knowledge of advanced calculus and ordinary differential equations is assumed.

Part 1 gives an introduction to Hilbert space and Part 2 deals with linear operators in  $\mathfrak{H}$ . The spectral theory of completely continuous operators is dealt with in Part 3, while Part 4 develops the theory of Schrodinger operators. Part 5 discusses the spectral theory of the Weyl differential operator. A special feature of the text is the emphasis on the various kinds of admissible boundary conditions, along with their applications to physics. A. S. G.

**Let Us Start Here.** By P. G. Roope. (Published by The World Publishing Company, 2231, West 110th Street, Cleveland, Ohio, U.S.A.), Pp. 102.

The book lists and annotates classical and modern readings, both scientific and literary, that are recommended to students of life sciences with a view to broadening their understanding of men, life and society.

The graduate student working for his Ph.D. and looking forward to a career is expected to have a certain degree of knowledge beyond the narrow range of his specialised study. He needs the help of experienced professors in the choice of books to be read so as to get maximum benefit with the limited time for extra reading at his disposal. Professor Roope has done a valuable job in bringing out this introduction to basic readings in the life sciences. He was inspired in this work by the book *To Begin With* by Professor Raymond Pearl published 40 years ago, which supplied essential reading for graduate students of biology. Many books from this publication have been included in the present volume.

The selection of about 100 books includes: Aristotle's *Historia animalium*, Flaubert's *Bouvard et Pecuchet*, Karl Pearson's *Grammar of Science*, Whitehead's *Science and the Modern World*, Buckle's *History of Civilization*, Fowler's *Modern English Usage*, Mark Twain's *What is Man?* and Mead's *Mind, Self and Society*. A. S. G.

**Figs (*Ficus* Spp.) of Hong Kong.** By Dennis S. Hill. (Hong Kong University Press, Abroad through the Oxford University Press, Ely House, 37, Dover Street, London, W. 1), 1967. Pp. 130. Price HK \$60.

This publication represents part of a thesis submitted to the University of Hong Kong for the degree of Ph.D. The author has studied the fig plants of Hong Kong in their ecological and seasonal aspects and has investigated the



insects which live in symbiosis with them. As Prof. E. J. H. Corner says in his Foreword, "There can be few more remarkable relationships than the thriving success of the giant fig trees and the multitude of very small insects which sustain them."

Plants of the genus *Ficus* exist in a state of symbiosis with chalcid wasps belonging to the family Agaonidae. The agaonid wasps can only develop in the gall flowers of the figs, and the insects are the sole means of pollination for the fig flowers. A total of 27 species of *Ficus* (17 indigenous, 4 introduced and 6 herbarium collection) have been studied and recorded here. The fertile fruits yielded a total of 65 species of chalcid wasps. It was found that each species of *Ficus* had its own species of Agaonidae in its figs, and most species, in addition, had other chalcids belonging to the families Torymidae, Pteromalidae, Eurytomidae, Ormyrillae and Eulophidae. The vast majority of the wasps were completely host specific.

This monograph is sure to be of interest to researchers concerning symbiosis and parasitic evolution. The book contains 178 figures and 65 plates.

A. S. G.

## ANNOUNCEMENTS

### Award of Research Degree

Andhra University has awarded the Ph.D. degree to the following on subjects noted against each:

Sri. M. T. Rama Rao (Physics), Sri. V. S. Bhaskara Rao (Chemistry), Sri. V. Krishnamurthy (Chemistry), Sri. T. Ramamohana Rao (Geology), Sri. K. S. Raghavan (Zoology).

Sri. Venkateswara University has awarded the Ph.D. degree to the following on subjects noted against each: Sri. J. V. Srinivasa Rao (Botany), Sri. E. A. V. Prasad (Geology).

### Conference on Photographic Science and Technology

A Conference on Photographic Science and Technology was held on the 5th and 6th April 1968 at Ootacamund under the sponsorship of Hindustan Photo Films Mfg. Co. Ltd., Ootacamund, a Government of India Enter-

prise. The inaugural function was presided over by Shri H. C. Kothari, Chairman, Hindustan Photo Film Mfg. Co. Ltd. 49 delegates, including two from Britain and one from France attended the Conference. At the technical sessions 24 papers on different subjects were presented.

### Symposium on 'Reclamation and Use of Wastelands in India'

The symposium on "Reclamation and use of Wastelands in India" was held from May 10 to 12, 1968, at the premises of the National Institute of Sciences of India, Bahadur Shah Zafar Marg, New Delhi. The symposium was inaugurated by Prof. T. R. Seshadri, F.R.S.

Forty-one papers were presented at the symposium covering the following aspects:

(1) Soil survey classification, (2) Airphoto interpretation and mapping, (3) Development of forestry and grassland, (4) Colonisation, Economics and sociocultural aspects, (5) Reclamation of saline and alkali lands, (6) Reclamation of sand dunes (7) Reclamation of ravine lands, and (8) Reclamation and management.

### Books Received

#### *Organisational Biosynthesis—A Symposium.*

Edited by H. J. Vogel, J. O. Lampen and V. Bryson. (Academic Press, New York), 1967. Pp. xx + 549. Price \$19.00.

*Annual Review of Entomology* (Vol. 13). By R. F. Smith and T. E. Mittler (Annual Reviews, Inc., Palo Alto, California), 1968. Pp. 488. Price: U.S.A. \$8.50, Elsewhere \$9.00.

*Guide to Gas Chromatography Literature* (Vol. 1. By A. V. Singneur, (Plenum Press, New York, N. Y. 10011). Pp. 351. Price \$15.00; (Vol. 2), Pp. 379. Price \$15.00.

*The Planetarium and Atmospherium an Indoor Universe.* By O. R. Norton (Naturegraph Publishers, 8339 West Dry Check Road, Healsburg, California 95448), 1967. Pp. viii + 175. Price Cloth: \$4.50; Paper: \$2.75.

*Tobacco and Tobacco Smoke Studies in Experimental Carcinogenesis.* By E. L. Wynder and D. Hoffmann. (Academic Press, New York), 1968. Pp. xiii + 730. Price \$29.00.



METEOROLOGICAL FACTORS ASSOCIATED WITH THE ERGOT EPIDEMIC  
OF BAJRA (*PENNISETUM*) IN INDIA DURING THE KHARIF SEASON,  
1967—A PRELIMINARY STUDY

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I. INTRODUCTION

DURING the kharif season (south-west monsoon) in 1967, public attention was focussed on a disease of the Bajra crop, known as 'Ergot', in many parts of India. Although this disease has been known from the times of the Greeks and Romans, it seemed to be a new one so far as the Bajra crops in India were concerned. According to a leaflet issued by the Division of Mycology and Plant Pathology of the Indian Agricultural Research Institute, Delhi in October 1967, this disease appeared for the first time in cultivated varieties of Bajra in certain areas of the Maharashtra State in 1959. With the introduction of Hybrid Bajra No. 1 developed at the Punjab Agricultural University, Ludhiana, the disease spread to many Bajra-growing areas in India and it appeared in epidemic form during the kharif season of 1967 in many parts of the country. The fungal organism which incited this disease has been classified by the Indian Agricultural Research Institute as *Claviceps microcephala*.

Ergot contains a poisonous alkaloid. According to press reports, at least 20 persons died around Delhi towards the end of the monsoon season of 1967 by eating the infected Bajra. Loss of cattle was also reported in the newspapers. The disease also reduced the crop yield. The need for preventing a recurrence of this epidemic can be realised from the fact<sup>1</sup> that Bajra crop is cultivated over 27 million acres of land in our country and yields annually about 4 million tons of food grain.

II. METEOROLOGICAL FACTORS AND THEIR  
IMPORTANCE IN ERGOT-PATHOLOGY

Butler and Jones<sup>2</sup> and Walker<sup>3</sup> have discussed in detail the pathology of the Ergot disease. Although they do not mention about environmental factors specially applicable to India, they have clearly stressed the importance of meteorological factors in ergot-pathology. For instance they have pointed out that the minute conidia which are contained in the sticky yellow fluid known as 'honey-dew', can be carried from infected to healthy plants by swaying of the plants in wind and by splashing

rain. Again, according to Butler and Jones,<sup>2</sup> "the ascospores are extruded under conditions of high humidity of about 76 to 78% saturation of the atmosphere and may either collect at the ostioles in viscid masses for dispersal in splashing rain-drops, or if showers are followed by sunny periods, such conditions would liberate the spores from the perithecia and cause them to be forcibly ejected into the air and so may be carried further afield by the wind to any spikelets that may be open for the reception of pollen."

The importance of wind in the dissemination of the infection will be realised if we recall that during the south-west monsoon season, in the important Bajra-growing areas like Maharashtra and Rajasthan, steep pressure gradients prevail resulting in strong winds. It is interesting to recall in this connection that the Ergot disease first appeared in India in 1959 in Maharashtra.

III. PURPOSE OF THE PRESENT INVESTIGATION

As far as the writer is aware, no literature is available about the precise meteorological factors which influence at different stages the incidence and development of Ergot under Indian conditions. However, there is no doubt that the Ergot disease was much more widespread and severe in India in 1967 than in 1966. We shall therefore, assume for the sake of simplicity, that the initial conditions relating to the parasite and host-plant were more or less the same, both in 1966 and 1967 and examine how far the meteorological factors would have contributed to the greater incidence and extent of this disease in 1967. This assumption is of course not strictly justified because the sclerotia which fall to the ground during one crop-season may revive<sup>2</sup> before the next crop-season while on ground and generate ascospores which may lead to infection. Ergots are however fortunately not long-lived and do not remain viable on the ground for more than a year.\*

An investigation of this kind should, strictly speaking, be based on "precision records" as

\* Sunny clear skies in the pre-monsoon season (hot weather period) uninterrupted by unseasonal rain have a sterilising influence on the soil.

suggested by Ramdas.<sup>4,5</sup> Unfortunately, such records were not available in the present case. Nevertheless the writer has made this preliminary study, making use of whatever information was available about the general atmospheric conditions and about the growth of Bajra crop in Delhi area. This approach is justified in this preliminary investigation *as, according to our present knowledge, the fungal organism connected with Ergot, attacks only the flowers<sup>2,3</sup> of the crop which are exposed to the general atmosphere.*

#### IV. BASIC METEOROLOGICAL OBSERVATIONS AND CROP-WEATHER INFORMATION UTILISED IN THIS STUDY

The Safdarjung Airport and Lodi Road Observatories are less than a mile apart as the crow flies and the meteorological observations recorded at these two sites were utilised in this investigation. The observations at both these sites will be referred to in the rest of this article as "at the meteorological observatory, New Delhi". This observatory is about 5 miles to the east-south-east of the Experimental Research Farm of the Indian Agricultural Research Institute (I.A.R.I.), Delhi where Bajra is cultivated for research purposes. The general atmospheric conditions at the meteorological observatory, New Delhi may be considered to be representative of those at I.A.R.I. except in the cases of rainfall and relative humidity. Even in these two cases, the minor differences would not vitiate the broad conclusions reported in this article.

The India Meteorological Department† have compiled district-wise "Crop-Weather calendars showing the life-history and mean dates of important epochs of growth of crops in the various States. Although no crop weather calendar is available for Delhi State in respect of Bajra, calendars are available for this crop for a few districts in Rajasthan, the nearest district for which it is available being Churu which is only 12 kilometres (approximately) to the west-south-west of Delhi. These calendars supplemented by the author's discussions at the I.A.R.I. constituted the basic crop-weather information for this study.

#### V. METEOROLOGICAL CONDITIONS AT NEW DELHI AFTER THE ONSET OF THE SOUTH-WEST MONSOON IN 1967

The monsoon advanced into Delhi on 2nd July 1967 and there were showers daily at

† The 'Crop-Weather Calendars' were first prepared by Dr. L. A. Ramdas in 1945.

Delhi between 2nd and 8th July 1967. It was understood during discussions at the I.A.R.I. that Bajra was sown in the Experimental Research Farm at the I.A.R.I. in different plots between 15th and 30th July 1967.

Figure 1 shows (a) the daily values of relative humidity and total cloud amount at 0830 and 1730 IST, (b) rainfall during the 24 hours ending at 0830 IST and (c) the total number of hours of sunshine daily, at the meteorological observatory, New Delhi, during July, August and September 1967. For purposes of comparison, the daily 0830 IST values of relative humidity and total cloud amount and the total number of hours of sunshine daily, in July, August and September 1966 have also been shown in the same diagram. The periods during which the Bajra was sown (July, 15th to 30th) and would have flowered (September 1st-10th) at the I.A.R.I., Delhi in 1967, are also shown pictorially in the diagram.

An examination of this diagram reveals the following:

- (a) The morning relative humidity was 85 to 95% between 1st and 10th September 1967. The evening relative humidity which is normally only 45 to 50% over Delhi at this time of the year, was 75 to 90% between 1st and 5th and 60 to 70% between 6th and 10th September.
- (b) The total cloud amount was six to eight octa (i.e., the sky was 75 to 100% covered) both morning and evening between 1st and 8th September 1967. Normally the sky over Delhi is covered only about one-third at this time of the year.
- (c) The total number of hours of sunshine was only 1 to 5 hours daily between 1st and 7th September 1967. Normally the duration of sunshine at Delhi in September is 7 hours.
- (d) There were showers daily between 1st and 6th September 1967. Rainfall was as much as 38 millimetres during the 24 hours ending at 0830 IST on 2nd.

#### VI. METEOROLOGICAL CONDITIONS AT NEW DELHI AFTER THE ONSET OF THE MONSOON IN 1966, A YEAR OF NO EPIDEMIC OF ERGOT

In 1966, the monsoon advanced into Delhi and the neighbouring areas on 25th to 26th July. The dates of sowing, flowering, etc., of Bajra over Delhi area in 1966 are unfortunately

not available and hence are not specifically discussed here. However, the attention of the reader is invited to the low relative humidity and the little cloud amount even at 0830 IST and the long duration of sunshine during most of the period covering the last ten days of August and the first fortnight of September 1966, in Fig. 1.

#### VII. PROGRESS OF RAINFALL WEEK BY WEEK IN 1966 AND 1967

Table I shows the rainfall in the different weeks between the 26th week (June 25 to July 1) and the 38th week (September 17-23) in 1966 and 1967 and the normal rainfall during the same period based on the data of a large number of years. The weeks cover the same periods as in the crop-weather calendars of the India Meteorological Department. The rainfall of 50% in excess of the normal in the 31st week (30th July to 5th August 1967), of more than 300% in excess of the normal in the successive 3 weeks (32nd, 33rd and 34th) followed by rainfall of nearly 50 to 60% in excess of the normal in the 35th and 37th weeks in 1967 are significant from the point of view of our investigation. It will be noted that the picture of the weekly rainfall in the same period in 1966 is different.

#### VIII. MEAN HOURLY SURFACE WIND-SPEEDS AT NEW DELHI IN SEPTEMBER 1967 AND 1966

An examination of the mean hourly surface wind-speeds tabulated from the records of the Dines Pressure Tube Anemograph at the

meteorological observatory at New Delhi, shows that, in the first half of September 1967 as well as of September 1966, the mean hourly speeds did not exceed 28 kmph at any time nor did they persist even at this speed long enough to suggest the possibility of spreading of infection as an effect of winds.

#### IX. LARGE-SCALE METEOROLOGICAL SITUATION OVER NORTH-WEST INDIA (INCLUDING DELHI STATE), DURING THE PERIOD OF FLOWERING OF BAJRA IN 1967

The large-scale meteorological situation over north-west India between 1st and 10th September 1967 was interesting. Conditions similar to those at Delhi prevailed over an area of at least 65,000 sq. miles (1,66,400 sq. km.) with Delhi close to its northern border between 1st and 7th September. These conditions shifted progressively west-south-westwards after 7th September. The large-scale weather systems at all levels in the atmosphere between the ground and 16 km. were favourable for sustained wet spell over an extensive area with Delhi almost at its northern fringe, during the normal flowering period of the Bajra. Our analysis thus supports the greater incidence of the Ergot disease in Gurgaon and other areas to the south of Delhi as reported in the Delhi Press.

In contrast to the above, there was nothing striking in the large-scale meteorological situation during the corresponding period in September 1966. From 24th August 1966 to

TABLE I  
Rainfall at the meteorological observatory, New Delhi, week by week

Weeks	Normal Rainfall (Whole mm.)	1966		1967	
		Actual Rainfall (Whole mm.)	Excess or defect with respect to the normal rainfall, expressed as a percentage	Actual rainfall (Whole mm.)	Excess or defect with respect to the normal rainfall, expressed as a percentage
26 (June 23-July 1)	30	105	+250	21	- 30
27 (July 2-8)	32	2	- 94	223	+596
28 (July 9-15)	38	0	-100	5	- 87
29 (July 16-22)	51	2	- 96	13	- 75
30 (July 23-29)	45	72	+ 60	18	- 60
31 (July 30-Aug. 5)	56	104	+ 86	84	+ 50
32 (Aug. 6-12)	41	92	+124	186	+354
33 (Aug. 13-19)	29	28	+ 3	120	+314
34 (Aug. 20-26)	34	1	- 97	147	+332
35 (Aug. 27-Sept. 2)	3	0	-100	52	+ 49
36 (Sept. 3-9)	30	51	+ 70	22	- 27
37 (Sept. 10-16)	37	0	-100	60	+ 62
38 (Sept. 17-23)	36	17	- 53	1	- 97

N.B.— Figures in *italics* represent actual rainfall which is equal to or less than half of the normal rainfall. Figures in **thick type** represent actual rainfall which is equal to or more than twice the normal rainfall.

7th September 1966, no large-scale rain or cloud-producing system affected north-west India (including Delhi State). Consequently during this period, the entire Bajra-growing area in north-west India, experienced very weak monsoon conditions with plenty of sunshine.

#### X. CONCLUDING REMARKS

This preliminary study has brought out the importance of meso- as well as large-scale meteorological factors in the incidence of Ergot disease of Bajra. However, it has to be followed up by a more exhaustive study based on a well-co-ordinated observational *cum* research

#### ERGOT OF BAJRA AT DELHI DURING KHARIF 1967 AND METEOROLOGICAL FACTORS

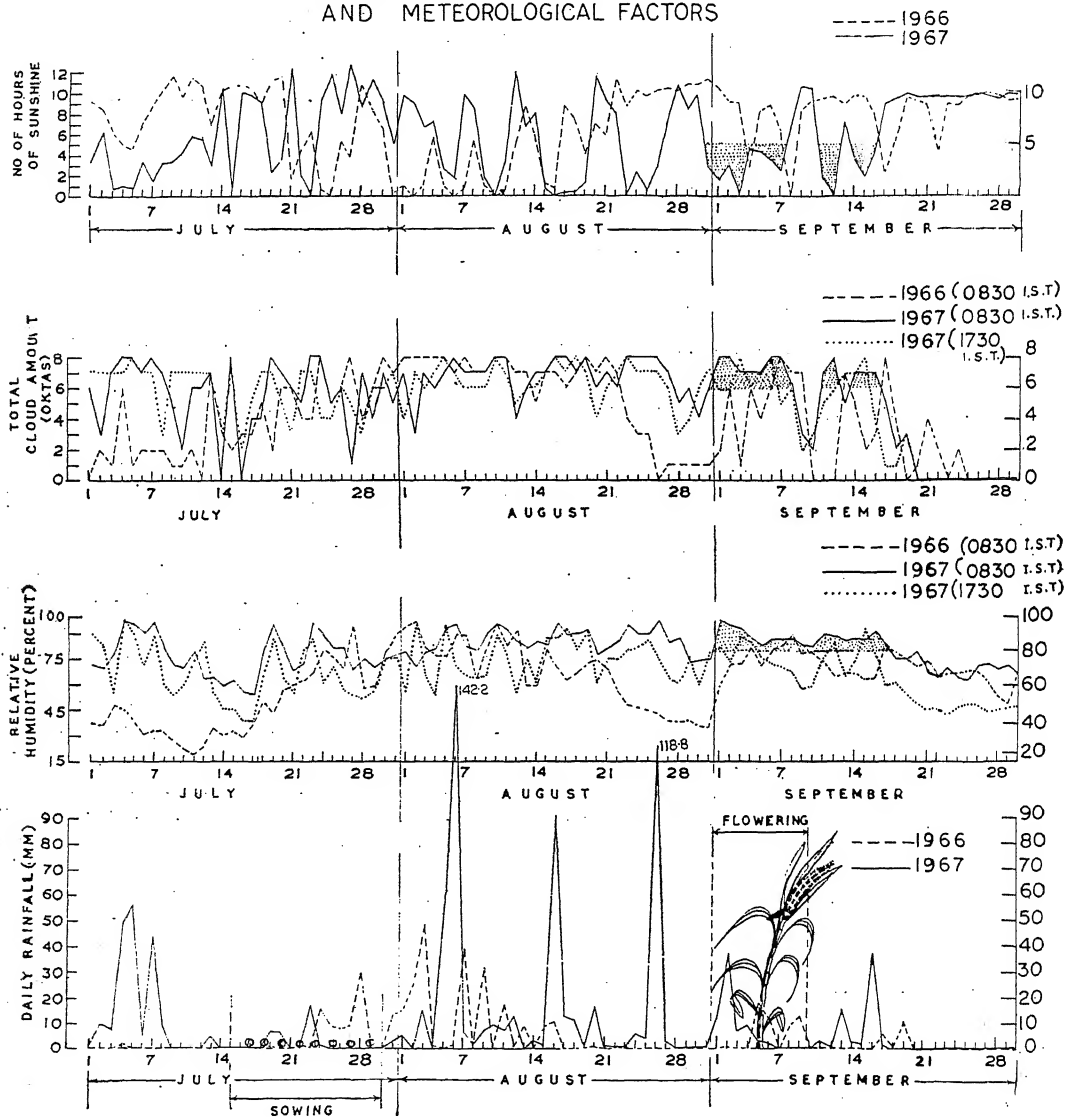


FIG. 1. The period of sowing, between 15th and 30th July 1967 and the period of flowering between 1st and 10th September 1967 shown pictorially in the bottom portion of the diagram may be specially noted. The stippled portion of the diagram, in September, shows the portions of the flowering period when the duration of sunshine was less than 5 hours in the day, the total cloud amount was more than six oktas (more than 75% of the sky covered) and the relative humidity was more than 80%. Compare the conditions in 1967 with those in 1966.

programme drawn up jointly by agro-meteorologists and plant pathologists and carried out over a number of years.

#### XI. ACKNOWLEDGEMENT

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of Observatories, New Delhi, for according permission for using the meteorological data of the observatories at New Delhi and for providing other facilities for this investigation.

1. *Directory and Year-Book of Times of India*, 1965, p. 342.
2. Butler, E. J. and Jones, S. G., *Plant Pathology*, Macmillan and Co., 1949, p. 445.
3. Walker, J. C., *Ibid.*, McGraw-Hill Book Company, Inc., 1950, p. 349.
4. Ramdas, L. A., 'Climatic factors in agriculture,' *Indian Farming*, Imperial Council of Agricultural Research, 1945, 3 (5).
5. —, *Crops and Weather in India*, ICAR Monograph, 1960.

### ADRENERGIC RECEPTOR (S) AND CALCIUM

N. R. KRISHNASWAMY AND A. S. RAMASWAMY

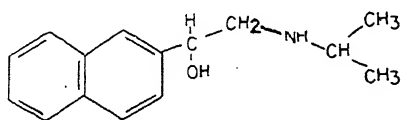
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THE nature of the adrenergic receptor(s) has been the subject of intense study particularly since Ahlquist's classification of these into  $\alpha$ - and  $\beta$ -types.<sup>1</sup> Based on the available data Belleau<sup>2</sup> suggested a model of the  $\alpha$ - and  $\beta$ -receptors and the mode of their interaction with the catecholamines and related compounds. In a recent paper he has elaborated his earlier ideas to take into account new data.<sup>3</sup>

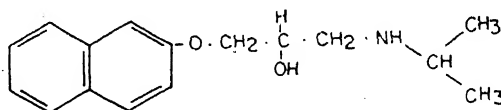
We wish, herein, to deal with an aspect not emphasised earlier and which appears to us as of considerable importance in the further understanding of the subject. The role of calcium ions in adrenergic activity is well known and Belleau<sup>3</sup> has in fact taken this factor into consideration while elaborating his picture of interaction with the  $\alpha$ -receptor. However, he has not discussed its role with regard to the  $\beta$ -activity, though data are not lacking on the importance of calcium ions in  $\beta$ -adrenergic activity. In this context the recent interesting observations of Naylor<sup>4</sup> on the influence of adrenaline and some adrenergic blocking drugs on the 'lipid facilitated transport' of calcium ions deserve careful consideration. Naylor found that lipids extracted from microsomal and mitochondrial fractions of the hearts of rabbit, guinea-pig and other animals facilitated transport of calcium ions from the Ringer's solution into a lipid solvent phase. This transport was inhibited by

the addition of pronethalol (I) and propranolol (II), the two typical  $\beta$ -adrenergic blocking agents to the Ringer's solution, whereas it was potentiated by the addition of adrenaline (III) and nor-adrenaline (IV) and not altered by the addition of tyramine (V).

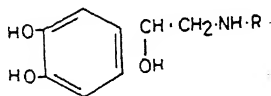
An interpretation of the above data is the following and could lead to interesting corollaries. From Naylor's data,<sup>4</sup> it may be inferred that the adrenergic blocking drugs as well as adrenaline and nor-adrenaline are able to bind calcium, whereas tyramine is unable to do so, and this appears more probable as the drugs under study were added to the Ringer's solution containing calcium prior to extraction with the lipid. Under the experimental conditions interaction of the drugs with the lipid as the primary process is unlikely. Further the calcium-pronethalol/propranolol combination is obviously lipid insoluble, thus keeping down the calcium in the aqueous phase in contrast to the calcium-catecholamine combination which is lipid soluble. The capacity of these compounds to bind calcium can be traced to the presence of an alcoholic hydroxyl, which is absent in tyramine. On the other hand, it is likely that the catechol group in adrenaline and nor-adrenaline enables their complexes to link on to appropriate polar functions in the bio-lipids and thus get transported to the lipid phase. The absence of such a functional group in the  $\beta$ -blocking drugs, would then explain



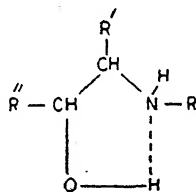
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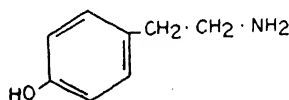
II

III R = CH<sub>3</sub>

IV R = H



VI



V

the lack of affinity of their calcium complexes for the lipid phase. At any rate what appears to differentiate between adrenaline and nor-adrenaline on the one hand and the adrenergic blocking drugs on the other is the lipid phase solubility of the calcium-complex of the former and the insolubility of the latter; both types, however, bind calcium. In view of the fact that phospholipids form part of the adrenergic receptor structure, the above observations may have deeper significance and herein may lie a clue to the mode of action of adrenergic blocking drug. Further Naylor's data show that adrenaline binds calcium more efficiently than nor-adrenaline and from the arguments below one could expect isoprenaline to be even more efficient. The catecholamine and allied compounds such as ephedrine, can be considered as ethanolamine derivatives and it is known,<sup>5</sup> that in the ethanolamines and ephedrine the alcoholic hydroxyl is hydrogen-bonded to the nitrogen as shown in (VI). They also form metal complexes and it is logical to expect the catecholamines to exhibit similar properties. The strength of the intramolecular H-bonding and hence the capacity to bind calcium among related compounds of this type would depend upon the nature of the substituents on the nitrogen and should increase as the (+) inductive effect of the group R increases, i.e., in the order, nor-adrenaline < adrenaline < isoprenaline. Interestingly enough, the same is the order in which the  $\beta$ -adren-

ergic activity increases. We thus find, that there is a definite parallelism between calcium binding capacity and adrenergic activity both depending, in an identical manner upon the structural parameters pointed out earlier by Pratesi and Grana.<sup>6</sup> Pratesi and Grana further pointed out, that when a predominantly  $\alpha$ -active substance is allowed to act on an organ containing only  $\beta$ -receptors, a  $\beta$ -type effect is obtained and *vice versa*. In terms of the arguments set out above this could mean that, apart from the structure of the catecholamine, availability of calcium ions in the environment of the receptor could be a major factor in deciding the character of the response. More studies are, however, necessary before the theme could be further delineated.

The authors' thanks are due to Prof. T. R. Seshadri, University of Delhi, and Prof. K. L. Wig, Director, All-India Institute of Medical Sciences, New Delhi, for their keen interest and encouragement.

1. Ahlquist, R. P., *Amer. Jour. Physiol.*, 1948, **153**, 586.
2. Belleau, B., *Pharmacol. Revs.*, 1966, **18**, 131; *Advances in Drug Research*, (Ed.) Harper, N. J. and Simmond, A. B., Academic Press, New York, 1965, **2**, 89.
3. —, *Ann. N.Y. Acad. Sci.*, 1967, **136**, 780.
4. Naylor, W. G., *Jour. Pharm. Exper. Therap.*, 1966, **153**, 479.
5. Kanzawa, T., *Bull. Chem. Soc. Japan*, 1956, **29**, 398, 479 & 604.
6. Pratesi, P. and Grana, E., *Advances in Drug Research*, (Ed.) Harper, N. J. and Simmonds, A. B., Academic Press, New York, 1965, **2**, 127.

# REGULATIVE-ADAPTATION TO TEMPERATURE AND ITS INFLUENCE THROUGH LIGHT ON THE CELLULAR AUTOTROPHY\*

## Part II, 4. Cellular Reactions of Two Algal Strains Upon Shifts to Limit-Temperatures Under 20-Kilolux

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### I. LOW TEMPERATURE REACTIONS: *Chlorella* 211/8K.

**INTRODUCTION.**—The photosynthetic-“Reaction norm” in 20-Kilolux light intensity under the regulative-adaptation to temperature of two algal strains has been established (Part-I)\*. In order to understand further responses to active metabolism, the so-called high-temperature strain *Chlorella* 211/8K, has been allowed to react at low temperature shift.

**Experimental.**—The selected strain prefers to grow at higher temperature (reported to be at 39° or higher up) having a tendency towards refusal of cell-division and growth at 15° in 20-Kilolux. Consequently, harvested at 25°/20 K-lux by 12/12 hours, light/dark, after 6 hours light, the cells are allowed to the shifting-reaction at 15°/20-Kilolux. The cells are synchronised at 25° affording a unique experimental approach towards accurate determination of the cell-substances to explain the temperature-shift mechanism.

**Results.**—As represented in (Fig. 1 a, b, c) a 30-hours' observation gives a slight increase in dry-matter and the negligible yield in cell-number by counts. Significantly, a strong production of RNA is observed but the amount of DNA remains practically unchanged. The RNA-production corresponding to the increase of total-protein in turn, is presumably synthesised at the cost of decrease in the reserve-carbohydrate,  $C(H_2O)$  or the carbohydrates produced at the initial active and gradual passive photosynthetic reactions of the cells. The residual dry-matter for the increasing slight change as such may be explained from the total- $C(H_2O)$ -balance so far as the present experimental evidences are in support.

Parallel to cellular analysis, the photosynthetic rate sinks down in response to the regulatory stay at 15°-shifting. The rate measured at 30°, however, shows a positive value towards photosynthetic- $O_2$  evolution even after 30 hours' shifting-regulation. It is therefore inferred that the effect of low-temperature reaction under sufficient light energy from 20-Kilolux, the cellular-RNA continues its synthesis correspondingly to protein level increase which in turn continues its production at the cost of cellular carbohydrate reserve showing the  $C(H_2O)$ -level decrease.

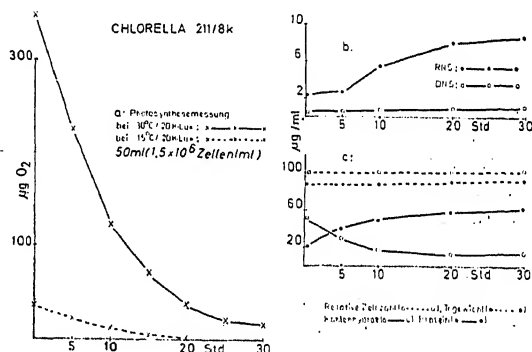


FIG. 1. *Chlorella* 211/8K Reactions to lower temperature (15°)-shifting. (a) Photosynthesis 50 ml. ( $1.5 \times 10^6$  cells/ml.), (b) RNA (RNS), DNA (DNS). (c) Relative cell-count (O—O), Dry-weight (●—●), Carbohydrate (O—O), and Protein (●—●). Hour (Std.).—Dr. Das.

### II. EXPERIMENTS WITH PSEUDOCHELORELLA

It is a low-temperature strain selected to compare the cellular behaviour with that of the previous 211/8K-strain so that the reaction-mechanism of the cellular-dynamics can be more accurately established. A modified procedure has been followed: the cells are allowed to react first at 20/30° (72-hr.) in periodic 12/12-hours' shifts instead of light/

\* Portion of the is submitted for Doctorate, Institute of Plant Pathology, University of Göttingen, W. Germany.

dark, by continuous 20-Kilolux. This procedure regulates the arrest of cell-division for the low-temperature strain at lower temperature but allows only at 30°/20 K-lux. The cells are then set to the shifting regulation at 10°/20 K-lux.

**Results.**—Fig. 2 a, b, c represents similar behaviour of the cellular constituents in establishing the mechanism.

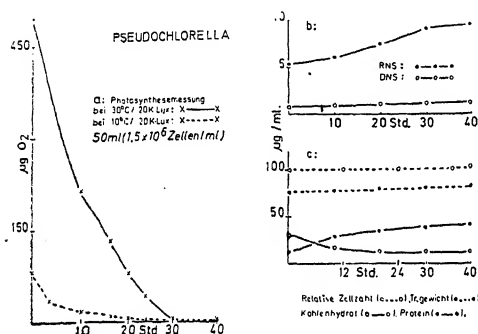


FIG. 2. *Pseudochlorella* (a), (b) and (c): descriptions same as in Fig. 1 and also text.

### III. SHIFTING-REACTIONS AT HIGHER TEMPERATURE

The strain *Pseudochlorella* offers itself on genetical ground to respond to the higher temperature regulations. It is not easy to control the strain-211/8K at higher-temperature for analytical purposes. Therefore, *Pseudochlorella* has been selected to show more clearly the cellular reactions with regard to upper level of temperature shift. The results have been represented in (Fig. 3 a, b) to direct that the increase in cell-count at 25°/20 K-lux, is optimum. The cells are raised from solid agar-mineral medium at room-temperature (18–22°) and allowed to react for 30 hours in standard liquid mineral media. At 30° it is clearly observed that a strong depreciation towards increase in cell-number is counted. Negligible count increase is observed at 15° and at 10° complete arrest in cell-division by 20 K-lux, can be observed.

It is to be noted here that, upper-temperature shift brings about the nucleic acids-level not similar to that at the lower-temperature shift for *Pseudochlorella* under 20 K-lux. The difference is surely considerable to observe that at 25° the synthesis of DNA and RNA is co-ordinated. Although a slight increase

in DNA-content at 30° can be seen, a strong decrease in RNA-amount follows like a pattern of *middle-hill decline* of total-RNA and consequent to it is also the arrest of cell-division at this upper-temperature of cellular regulatory mechanism.

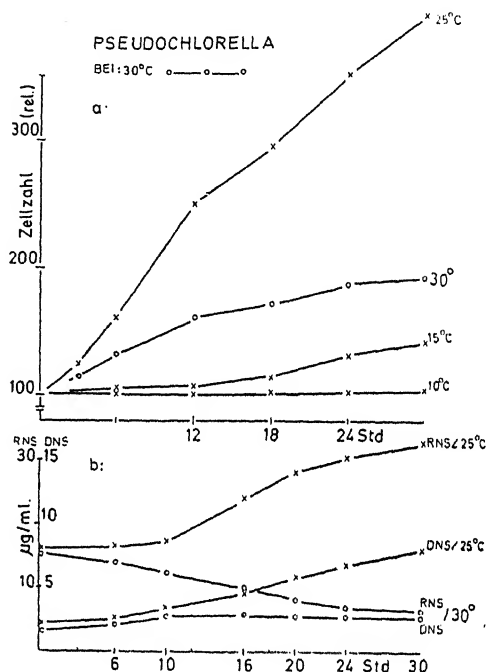


FIG. 3. *Pseudochlorella* at 30° (O—O—O) (a) Shifting to (30°) higher temperature. To compare (x) at 10, 15 & 25°. (b) RNA (RNS), DNA (DNS), 25° (x), 30° (o). Cell-counts (Zellzahl rel.), Hour (Std.).—Dr. Das.

### IV. CONCLUDING REMARKS

It has been communicated by Johnson and James (1960) that there is an increase of cell-volume without any change in dry-matters when the cells of *Chilomonas paramecium* are incubated at lower temperature-shift, the increase of volume has been shown only due to accumulation of water. The present observations on the two algal-strains communicate that RNA-accumulation in the cell allows to volume increase where the total dry-matters may remain practically unchanged due to the effect of lower temperature shift. The photosynthetic carbohydrates in reserve, as synthesised from the saturated light energy supplied at lower temperature-shift induces protein-synthesis in stimulation to RNA-increase over DNA.—it certainly follows at the



cost of total-carbohydrate conversion to protein in *Pseudochlorella* under the cellular volume-increase process. *Chlorella* 211/8K. gives more doubtless experimental support on this shift-reaction at low temperature by virtue of the authoritative responses vested upon the strain in fuller details.

Contrasting at the upper temperature-shift, a weak synthesis of DNA without cell-division is observed. The accompanying nuclear-mitosis is evidenced by Feulgen-nuclear reactions (-communicated elsewhere) showing many colour-centres per cell, which are yet seldom observed at the lower temperature-shift. The block of cell-division under such nuclear-mitotic condition may therefore be explained that at higher temperature the process stands not only on the sufficient DNA-production, but upon another factor that lowers RNA-level

associated with plasma-divisions also. Gross and Jahn (1962), however, have given an hypothesis on the possibility of the formation of some thermo-stable or, under certain condition, thermo-labile proteins responsible for *Chlamydomonas*-reactions to thermal-stresses.

But, based upon the major photosynthetic process of the autotrophic cells, subsequent experiments with promoter substances as co-factors or co-substrates (-communicated elsewhere) have developed the present idea on the nucleic acids-level of the cellular metabolism to give satisfactory explanation to this modern issue on the regulatory temperature reactions.

1. Johnson, B. F. and James, T., *Expt. Cell Res.*, 1960, 20, 66.
2. Gross, J. A. and Jahn, T. L., *J. Protozoo.*, 1962, 9, 340.

## USE OF RADON MEASUREMENTS TO DETERMINE SOURCE OF THE SOUTH-WEST MONSOON CURRENT OVER THE ARABIAN SEA

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RAMA<sup>1</sup> has suggested that radon (half-life 91 hours) measurements over the Arabian Sea can be used to determine whether the south-west monsoon current is primarily of northern hemisphere origin—from north-east Africa and Arabia or of southern hemisphere origin—south-east trades which have crossed the equator. The basis of this suggestion is that the air from across the equator would be poor in radon, while the air from north-east Africa and Arabia would be rich in radon. In a paper on "Radon in monsoon current" Rama<sup>2</sup> presented results of radon measurements at the deck-level of ships and showed that in the region of the south-east trades, the radon concentration ranged between 2 and 4 dpm/m<sup>3</sup>, while that over the Arabian Sea was often ten times as much. The following questions are relevant regarding Rama's suggestion:

(a) Is the air mass over the Arabian Sea not adulterated?

During the monsoon months (i) there is presence in the surface layers of a belt of

moderate to strong south-westerly winds 200-500 km. wide off the Somalia-Arabian coast between about 6° and 18° N and (ii) a trough of low pressure extends from inland Somalia across south-east Arabia to the main heat—low over West Pakistan. The International Indian Ocean Expedition (IIOE) results have shown that the south-westerly to westerly air over the Arabian Sea is moist and has unstable lapse upto about 1.0 to 1.5 km. and that there is above it drier air with nearly dry adiabatic lapse on some occasions with an inversion between the two air masses and less moist air with nearly saturation adiabatic lapse and with or without an inversion between the two air masses on other occasions.<sup>3,4</sup> To the west of the axis of the trough there will be relatively dry continental air with high radon concentration; to the east of the axis the drier radon-rich continental air would be drawn along with the south-westerly to westerly moist air with relatively much less radon or which is poor in radon.

Further, the air from across the equator which has travelled within about 200–300 km. of the African coast south of about 6° N. can also have more than 2–4 dpm/m<sup>3</sup> radon concentration as a result of the radon-rich air which has travelled over the African coast, being drawn north-eastwards along with the radon-poor south-east trades or deflected trades air.

Thus over the Arabian Sea there would not be ordinarily either unadulterated radon-rich continental air or radon-poor air from across or near the equator. The adulterated air would move to the west coast of the Peninsula under the influence of the prevailing pressure distribution. The radon concentration of this mixed air would be between that of the radon-poor deflected trades (2–4 dpm/m<sup>3</sup>) and the radon-rich continental air (20–40 dpm/m<sup>3</sup>).

(b) Taking it for the sake of argument that the air over the Arabian Sea is of continental origin with radon concentration of 20–40 dpm/m<sup>3</sup>, is it possible for that dry warm air to pick up sufficient moisture from the cooler sea surface during its travel north-east to east over the Arabian Sea?

The IIOE results have shown that when the warm continental air travels over the colder sea surface, an inversion (stable condition) develops right from the surface and little moisture is transported upwards due to presence of the inversion. On the other hand, moisture is added due to evaporation from the sea surface in the levels below the inversion when cooler deflected trades air with unstable lapse moves to warmer latitudes or areas north-east to east.<sup>5,6</sup> It is also seen from the IIOE results that marked changes in the depth of the moist current take place only within about 500 km. of the Western Ghats, the moist layer becoming about 6.0 km. deep on the west coast; there is absence of inversion and considerable rain also occurs on the coast.<sup>3-5</sup>

It is known that when the air from Arabia side presumably rich in radon reaches the west coast of the Peninsula in May, little or no rain occurs there. This is due to the fact

that the dry warm continental air while travelling over the Arabian Sea is not able to pick up any appreciable amount of moisture. Further, the layer of the moist unstable deflected trades air acts as a reservoir from which moisture can be transported upwards by Cu and Cb activity,<sup>5</sup> while the stable layer of the dry continental air cannot do so.

(c) Can the westerly air over the Arabian Sea be always of continental origin, i.e., from north-east Africa and Arabia?

The westerly air over the Arabian Sea need not always be from Arabia side. It can be even from across the equator, the direction having changed from south-west to west under the prevailing pressure distribution. One can be sure of the source of the air mass only if its trajectory is traced backwards.<sup>6</sup> The IIOE results have shown that the direction of the moist deflected trades changes from south-west in the south-west Arabian Sea to west in the east Arabian Sea off the west coast, the speed decreasing at the same time from 20–35 kt. to about 10 kt.

In view of what has been stated above, it would appear that interpretation of radon results from the point of identifying air masses is not easy unless the latter are unadulterated. Radon results represent integrated effect of various factors and can be utilised for day-to-day forecasting only if they are considered with reference to the synoptic charts.\*

\* A detailed paper on "Possible radon concentration over the Indian seas during the South-west Monsoon Season on the basis of climatic features of the area and utilisation of the Radon results for identifying air masses" has been submitted for publication to the India Meteorological Department.

1. Rama, *Ind. J. Meteor. Geophys.*, 1966, **17**, 651.
2. —, *Abstract of Papers of the NISI/INCOR Symp. on Indian Ocean*, New Delhi, Abstract No. 62, 1967, p. 28.
3. Desai, B. N., *J. Atmos. Sci.*, 1967, **24**, 216.
4. —, *Proc. Ind. Acad. Sci.*, 1967, **66A**, 306.
5. —, *Ind. J. Meteor. Geophys.*, 1966, **17**, 559.
6. —, *Ibid.*, 1967, **18**, 403.

## LETTERS TO THE EDITOR

### A COMPARISON OF THE THERMAL EXPANSIONS OF SELENIUM AND TELLURIUM

DESHIPANDE AND PAWAR<sup>1,2</sup> have obtained the values of the lattice parameters of selenium and tellurium at different temperatures. The mean principal coefficients of thermal expansions of selenium between 30° and 162° C. are  $\bar{\alpha}_a = 83.2 \times 10^{-6}/^\circ\text{C.}$  and  $\bar{\alpha}_c = -16.4 \times 10^{-6}/^\circ\text{C.}$  and those calculated for tellurium in the temperature range 25° and 201° C. are  $\bar{\alpha}_a = 28.3 \times 10^{-6}/^\circ\text{C.}$  and  $\bar{\alpha}_c = -2.53 \times 10^{-6}/^\circ\text{C.}$  These results show that the expansion coefficients in the 'a' direction are roughly in the ratio 3:1 and for the 'c' direction the ratio is 6:1. A simple qualitative explanation for this, taking into consideration the binding forces between the atoms in different directions in the two crystals, is offered below.

The structure of hexagonal selenium and tellurium consists of chains of atoms extending parallel to the 'c' direction of the hexagonal cell as shown in Fig. 1a. The binding between the atoms in the same chain is considered to be covalent and that between the atoms belonging to the neighbouring chains is between covalent and Van der Waals.<sup>3,4</sup> But, the energies of the bonds between Se-Se and Te-Te in the same chain quoted by Pauling<sup>5</sup> as 44 K cal./Mole. and 33 K cal./Mole. respectively, show that the bonding between Se-Se is more covalent than the bonding of Te-Te atoms in the same chains. On heating the metals, an expansion takes place in both the principal directions. However, an elastic contraction dominates a small expansion produced in the 'c' direction as shown in Fig. 1b by  $\Delta C$  and causes a net decrease in this parameter. Apart from this, the bondlengths ( $d$ ) also increase with rise of temperature [shown in Fig. 1b by  $\Delta C$ ]. But, on the basis of the above arguments, the increase in the bondlength of selenium would be less than that of tellurium. The effect of the expansion of the bonds shown in Fig. 1b, is to compensate, partly, the contraction produced in the 'c' direction. In the case of selenium, since the bond expansion is less, the decrease in the

'c' parameter, therefore, cannot be compensated as much as that in tellurium. This furnishes an explanation for the observed larger coefficient of negative thermal expansion along the 'c' direction of selenium, compared to that of tellurium.

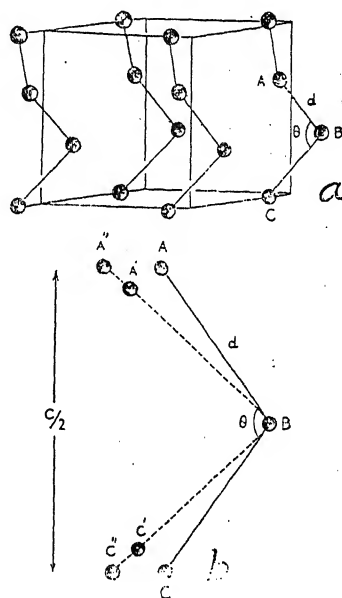


FIG. 1. (a) Structure of Se & Te. (b) Figure showing the decrease in "C" parameter with increase of temperature (for explanation *see text*).

The author wishes to thank Dr. V. T. Deshpande for his encouragement and helpful discussion in preparing this paper.

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Nagarjunasagar Engg. College,  
Hyderabad-28, February 29, 1968.

1. Deshpande, V. T. and Pawar, R. R., *Curr. Sci.* 1964, **33**, 741.
2. — and —, *Physica*, 1965, **31**, 671.
3. Von Hippel, A., *J. Chem. Phys.*, 1948, **16**, 372.
4. Grison, E., *Ibid.*, 1951, **19**, 1109.
5. Pauling, L., *The Nature of the Chemical Bond*, 1960, p. 85.

### 2', 3', 4'-TRIHIDROXY CHALCONE AS AN ANALYTICAL REAGENT FOR NIOBIUM AND TANTALUM

THE available methods for the determination of niobium and tantalum have been reviewed by Cockbill.<sup>1</sup> The *o*-phenolic chalcones do not appear to have been examined as reagents for these metals. In the course of investigations on the use of organic reagents for the detection and determination of niobium and tantalum, 2'-hydroxy-, 2 : 2'-dihydroxy-, 2' : 4'-dihydroxy-, 2' : 4'-dihydroxy-4-methoxy-, 2' : 4' : 4'-trihydroxy-, 2' : 3' : 4'-trihydroxy chalcones were examined. The chalcone last mentioned alone yielded an orange-red precipitate with niobium and an yellow precipitate with tantalum from oxalate complex solutions at pH 5.9-7.2 and pH 5.0-6.2 respectively. These complexes were insoluble in dilute acetic and mineral acids as well as ether but sparingly soluble in alcohol and acetone. In the presence of hydroxylamine hydrochloride niobium, however, gave an yellow precipitate. This reagent, though not specific, was highly sensitive both for niobium and tantalum and can be used as a spot reagent for these metals. The sensitivities of these reactions were determined according to Feigl's method.<sup>2</sup> The limits of identification (and dilution) were 0.5  $\gamma$  (1 : 10<sup>6</sup>) and 2.0  $\gamma$  (1 : 10<sup>5</sup>) for niobium pentoxide and tantalum pentoxide respectively.

This reagent has now been examined for the gravimetric estimations of niobium and tantalum from oxalate complex solutions.

**Procedure.**—Niobium pentoxide and tantalum pentoxide supplied by the Atomic Energy Establishment, Trombay, containing not more than 250 p.p.m. of tantalum pentoxide in the former and 300 p.p.m. of niobium pentoxide in the latter were used.

250 mg. of the anhydrous pentoxide was accurately weighed, dissolved in molten potassium pyrosulphate, the cold melt extracted with saturated ammonium oxalate solution and made upto 250 ml. with water in a volumetric flask. A measured volume of this solution was transferred into a 400 ml. pyrex beaker, diluted to about 80 ml. with distilled water and treated with a small excess of alcoholic solution of 2' : 3' : 4'-trihydroxychalcone (0.2% in rectified spirit), followed by 50-60 ml. of sodium acetate solution (15%). The precipitate was digested on the water-bath for one hour with occasional stirring and

filtered hot through a weighed sintered glass crucible (porosity No. 4). The precipitate was washed with hot water, drained completely under suction and washed finally with ether until the washings were colourless. The complex was dried to constant weight at 105-110° C. and weighed.

The results for niobium pentoxide and tantalum pentoxide are recorded in Tables I and II.

TABLE I

Niobium pentoxide taken (mg.)	Weight of chalcone complex (mg.)	Ratio of complex to niobium pentoxide	Percentage of niobium metal in the complex
5.0	19.4	3.88	18.02
10.0	38.9	3.89	17.98
15.0	58.3	3.88	17.99
20.0	77.7	3.88	17.99
25.0	97.1	3.88	17.99

TABLE II

Tantalum pentoxide taken (mg.)	Weight of chalcone complex (mg.)	Ratio of complex to tantalum pentoxide	Percentage of tantalum metal in the complex
5.0	11.1	2.22	36.90
10.0	22.3	2.23	36.73
15.0	33.3	2.22	36.90
20.0	44.4	2.22	36.89
25.0	55.4	2.22	36.96

The dried complexes contained 17.99% niobium and 36.88% tantalum and the results are reproducible. The usual methods of determining these metals involve ignition of the precipitated organic complexes to oxides before weighing. The chalcone complexes, however, could be dried to constant weight and this is a distinct advantage compared to tannin, cupferron and several other organic reagents used for the precipitation of niobium and tantalum.

The author wishes to express his grateful thanks to Professor K. Neelakantam for his kind interest in the work.

Dept. of Chemistry, R. RAGHAVA NAIDU.  
S.V. University College,  
Tirupati, April 20, 1968.

1. Cockbill, M. H., *Analyst*, 1962, **87**, 611.
2. Fritz Feigl, *Spot Tests*, Elsevier Publishing Company, Amsterdam, 1954, p. 4.

INFRA-RED SPECTRUM OF  
2, 6-DICHLOROTOLUENE

A NUMBER of workers have studied the infra-red spectra of substituted benzenes and systematized the observed vibration frequencies in terms of the symmetry species and modes of vibration. Methyl-substituted benzenes have been studied by earlier workers<sup>1,2</sup> as also chlorinated benzenes.<sup>3</sup> The infra-red spectra of 2, 4- and 3, 4-dichlorotoluenes have been reported.<sup>4</sup> In the present work the infra-red spectrum of 2, 6-dichlorotoluene has been studied in the region 2-25  $\mu$  on a Perkin-Elmer Model 21 spectrophotometer.

The observed fundamentals with the possible assignments are given in Table I.

TABLE I

Frequency (cm. <sup>-1</sup> )	Assignment
3096	C-H stretching
2933	CH <sub>3</sub> asym. stretching
2882	CH <sub>3</sub> sym. stretching
1597	C-C stretching
1570	C-C stretching
1435	CH <sub>3</sub> asym. bending
1376	CH <sub>3</sub> sym. bending
1266	C-H bending
1202	C-C-H <sub>3</sub> stretching
1086	CH <sub>3</sub> rocking
1000	C-C bending, trigonal mode
770	Ring breathing
692	C-C-I stretching
588	C-C-C bending
493	C-C-C bending
420	C-C-I bending

The above assignments have been made by comparing with the data on 2, 4- and 3, 4-dichlorotoluenes. The assignments of the ring breathing and trigonal C-C bending vibrations are in agreement with those proposed by Varsanyi<sup>5</sup> for such substituents.

Dept. of Chem. Tech., T. S. VARADARAJAN.  
University of Bombay, A. K. KALKAR.  
Bombay-19, March 28, 1968.

1. Pitzer, K. S. and Scott, D. W., *J. Am. Chem. Soc.*, 1943, **65**, 803.
2. Wilmschurst, J. K. and Bernstein, H. J., *Can. J. Chem.*, 1957, **35**, 911.
3. Mooney, E. F., *Spectrochimica Acta*, 1964, **20**, 1343.
4. Deb, K. K. and Banerjee S. B., *Ind. J. Phys.*, 1960, **34**, 554.
5. Varsanyi, by, *Acta Chimica Academiae Scientiarum Hungaricae Tomus*, 1966, **50**, 225.

FISSION OF THE PHOSPHORUS-  
SULPHUR BOND BY OXIDATION  
AND REDUCTION

SULPHUR-NITROGEN bond present in sulphur compounds containing nitrogen atom is easily ruptured either by reduction with hydrogen iodide<sup>1</sup> or by oxidation with chloramine-T.<sup>2</sup> It has now been observed that similar fission of P-S bond can be brought about by these two reagents. Thiophosphoryl chloride (PSCl<sub>3</sub>) was taken for this study as this could be prepared in a pure form in the laboratory.<sup>3</sup>

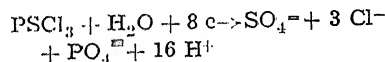
An aliquot of the solution of thiophosphoryl chloride in dioxan (5 ml.; m./100) is added to a known excess of acidified chloramine-T, [50 ml. (0.1 N) + 25 ml. (2 N) HCl] taken in a stoppered conical flask. The reaction is allowed to take place for about 30 minutes, and the excess of chloramine-T is estimated iodometrically. The analytical results (Table I) show

TABLE I

Oxidation of thiophosphoryl chloride by  
chloramine-T

Expt. No.	PSCl <sub>3</sub> (Mole $\times 10^{-4}$ ) taken for expt.	Equivalents of chloramine-T consumed $\times 10^{-4}$	Equivalents of chloramine-T consumed per mole of PSCl <sub>3</sub>
1	1.444	11.57	8.009
2	2.888	23.09	7.990
3	4.332	34.65	7.998

that eight equivalents of the oxidant are required for every mole of the thiophosphoryl chloride taken for oxidation. The P-S bond is broken and the sulphur is oxidised to sulphuric acid. The stoichiometry of the reaction may be represented by the equation:



When thiophosphoryl chloride is treated with excess of anhydrous hydrogen iodide in the vapour phase, iodine colour is observed. The reaction is rather sluggish and it requires a few hours (4-6) for completion. Hydrogen sulphide is found to be one of the products of reduction which can be separated and estimated iodometrically (Table II). One gram mole of hydrogen sulphide is produced for every gram mole of the thiophosphoryl chloride taken. The reduction may be visualized to take place in terms of the equation:

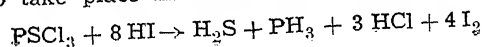


TABLE II

Reduction of thiophosphoryl chloride by  
hydrogen iodide

Expt. No.	PSCl <sub>3</sub> (Mole $\times 10^{-4}$ ; taken for expt.)	H <sub>2</sub> S formed (g. atm. of sulphur $\times 10^{-4}$ )	Iodine liberated per mole of PSCl <sub>3</sub>
1	1.326	1.336	1.147
2	3.065	3.030	1.369
3	4.502	4.486	1.311

Instead of eight equivalents of iodine as per equation, we find a little over one equivalent only, because of its consumption by phosphorus (III) compounds.<sup>4</sup>

Both these methods could be employed for the estimation of P-S compounds.

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and Physical Chem., A. R. VASUDEVA MURTHY.  
Indian Institute of Science,  
Bangalore-12, India, April 27, 1968.

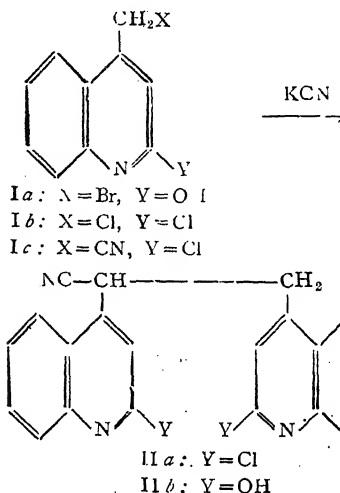
1. Vasudeva Murthy, A. R., *Proc. Ind. Acad. Sci.*, 1953, 37, 23.
2. Nair, C. G. R. and Vasudeva Murthy, A. R., *Chem. and Ind. (London)*, 1962, p. 1539.
3. Moeller, T., Birch, H. J. and Nielsen, N. C., *Inorganic Syntheses*, McGraw-Hill Book Co. Inc., New York, 1953, 4, 71.
4. Mellor, J. W., *Comprehensive Treatise on Inorganic and Theoretical Chemistry*, Longman's, London, 1928, 8, 827.

# SYNTHESIS OF 4, 4'-CYANOETHYLENE BIS-(2, 2'-DICHLORO QUINOLINE) AND 4, 4'-CYANOETHYLENE BIS-(2, 2'-DIHYDROXY QUINOLINE) DERIVATIVES

CHUDGAR and Trivedi<sup>1</sup> conclusively proved that bromination of aceto-acetanilide gave  $\omega$ -bromo-acetoacetanilide which on cyclisation gave 4-bromomethyl carbostyryl (Ia). This on treatment with phosphorus oxychloride, gave 2-chloro-4-chloromethyl quinoline (Ib), m.p. 97°. (Ib) when refluxed with alcoholic potassium cyanide solution gave 4, 4'-cyanoethylene bis-(2, 2'-dichloro quinoline) (IIa), m.p. 211°, and not 2-chloro-4-cyanomethyl quinoline (Ic).

4-Bromomethyl-2-hydroxyquinoline (Ia), on a similar condensation with potassium cyanide, gave 4, 4'-cyanoethylene bis-(2, 2'-dihydroxy quinoline), m.p. > 300° (IIb). This when refluxed with phosphorus oxychloride gave

(IIa). M.p. and mixed m.p. was 211°. All compounds described above gave satisfactory analytical results.



The structure of 4, 4'-cyanoethylene bis-(2, 2'-dichloro quinoline) is confirmed by NMR spectra shown in Table I.

TABLE I  
NMR spectra of (IIa). (60 MC. CDCl<sub>3</sub>)

Shift ( $\delta$ )	Coupling constant J (c/sec.)	Signals	Assignment
7.5 to 8.5	..	Multiplet	10 H (aromatic)
5.1	8	Triplet	1 H
4.2	8	Doublet	2 H

Synthesis of 4, 4'-cyanoethylene bis-(2, 2'-dichloro quinoline) derivatives having different groups is in progress and will be published elsewhere.

Thanks are due to Professor S. Sethna for his keen interest in the work and to Dr. Lele for microanalysis.

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1. Chudgar and Trivedi, *Curr. Sci.*, 1965, 34, 580.

STUDY OF THE NUCLEOPHILIC  
DISPLACEMENT REACTIONS USING  
METHYL 2, 6-di-O-MESYL- $\alpha$ -D-  
GLUCOPYRANOSIDE AS MODEL  
COMPOUND

I. Synthesis of Methyl-6-Azide-2-O-Mesyl  
 $\alpha$ -D-Glucopyranoside

NUCLEOPHILIC displacement of primary sulfonyloxy groups with sodium azide is a well-known method for the synthesis of amino sugars *via* the corresponding azido compounds. By the use of polar solvents recently it has also been possible to effect replacement of secondary mesyloxy groups. Our attempts were concerned mainly with the successive replacement of both the mesyloxy groups in methyl 2, 6-di-O-mesyl- $\alpha$ -D-glucopyranoside (I) with azido group using both the mild as well as drastic conditions. Crystalline-6-azido-2-O-mesyl glucopyranoside (II) was obtained in good yield. By reduction with Raney Nickel 6-amino-2-O-mesyl glycoside was synthesised as amorphous powder. Attempts to prepare the diazido compound either from the parent compound (I) or from the mono-azido glycoside (II) were not successful. At the prescribed conditions excessive decomposition of the starting material took place.

It is found from our experiments that only the primary mesyloxy group could be replaced with sodium azide under comparatively mild conditions, whereas the use of drastic conditions led to extensive decomposition of the starting material. Attempts to synthesise the di-azido using the mono-azide as starting material were also unsuccessful. Considering the reactivity of the hydroxyl functions in methyl- $\alpha$ -D-glucopyranoside, the structure of the mono-azido compound could be assigned as methyl-6-azido-2-O-mesyl- $\alpha$ -D-glucopyranoside.

(a) Reaction under mild conditions<sup>3</sup>

Methyl 2, 6-di-O-mesyl- $\alpha$ -D-glucopyranoside<sup>7</sup> (4.20 gm.) sodium azide (4.20 gm.) in acetone (50 c.c.) and water (15 c.c.) were refluxed for 72 hours. The reaction mixture was evaporated to dryness under reduced pressure (temp. 50° C.), extracted with chloroform, the chloroform extract was concentrated and cooled to 0° C. when a crystalline precipitate of methyl-2-O-mesyl-6-azido-6-deoxy- $\alpha$ -D-glucopyranoside was obtained (Yield: 30.04 gm. 85.4%). The product was purified by three successive recrystallisations from ethyl acetate, m.p. 135-36° C. Found: C, 32.23;

H, 5.07; N, 14.41; S, 10.75; calculated for  $C_8H_{15}O_7N_3S$ ; C, 32.32; H, 5.06; N, 14.14; S, 10.77.  $[\alpha]_D^{25}$  112.5° (C, 1.0 in water). IR Spectrum:  $\nu_{\text{max}}^{\text{CHCl}_3}$  2100  $\text{cm}^{-1}$  (S).

**Paper chromatography.**—Paper chromatography was carried out on Whatman No. 1 paper by downward irrigation with (a) the organic phase of *n*-butanol-ethanol-water (5:1:4 *v/v*) and (b) *n*-butanol-pyridine-benzene-water (5:3:1:3 *v/v*) and the spot was revealed by spraying with ninhydrin solution (0.2%) and *p*-anisidine hydrochloride (3% in *n*-butanol). This product had an  $R_f$  value of 0.80 in solvent (a) and 0.84 in solvent (b).

(b) Reaction under more drastic conditions

(i) A mixture of methyl-2, 6-di-O-mesyl- $\alpha$ -D-glucopyranoside (3.50 gm.), sodium azide (3.0 gm.) in dimethyl formamide (75 c.c.) and water (4 c.c.) were slowly heated in an oil-bath for 25 hours by gradually raising the temperature from 100° C. to 130° C. when the reaction mixture became dark brown. The reaction mixture was evaporated to dryness under reduced pressure (temp. 60° C.) and extracted with chloroform. The chloroform extract was concentrated and kept at 0° C. with the addition of a little ether when a crystalline precipitate was obtained. The crystals were decolourised with activated charcoal in acetone solution and purified by three successive recrystallisations from acetone-ether. (Yield: 1.2 gm., 40.4%), m.p. 135-36° C. Found: C, 32.56; H, 5.31; N, 14.32; S, 10.76. From the above evidences this crystalline compound was assumed to be methyl-2-O-mesyl-6-azido-6-deoxy- $\alpha$ -D-glucopyranoside (both these products co-chromatographed in solvent (a) as well as (b)).

(ii) Methyl-2, 6-di-O-mesyl- $\alpha$ -D-glucopyranoside (2.0 gm.) and sodium azide (2.0 gm.) in anhydrous dimethyl formamide (50 c.c.) were slowly refluxed for 2 hours (the temperature was slowly raised to the reflux temperature) when the reaction mixture became black in colour. On working up as above, a syrupy product of indeterminate composition (0.75 gm.) was obtained which could not be made to crystallise.

(c) Reactions using Methyl-2-O-mesyl-6-azido-6-deoxy- $\alpha$ -D-glucopyranoside as starting material

Methyl-2-O-mesyl-6-azido-6-deoxy- $\alpha$ -D-glucopyranoside (1.0 gm.) and sodium azide (1.0 gm.) in anhydrous dimethyl formamide (25 c.c.) were heated continuously for 60 hours

by gradually raising the temperature from 100° C. to 120° C. On working up as above the starting material was obtained back in 90% yield.

**Reduction of Methyl-2-O-mesyl-6-azido 6-deoxy -  $\alpha$  - D - glucopyranoside<sup>8</sup>.**—Methyl - 2 - O - mesyl - 6 - azido - 6 - deoxy -  $\alpha$  - D - glucopyranoside (1.5 g.) was dissolved in methanol (30 c.c.) and Raney Ni Catalyst (No. 28, 5.0 gm.) was added in two instalments during 48 hours with occasional stirring. The reaction mixture was evaporated to dryness under reduced pressure (temp. 45° C.) when the entire thing smells to a white foam which could be ground to a fine powder (m.p. 63–66° C. Yield: 1.20 gm., 92%). Found: C, 35.41; H, 6.42; N, 5.38. Calculated for methyl-2 - O - mesyl - 6 - amino - 6 - deoxy -  $\alpha$  - D - glucoside.  $C_8H_{17}O_7NS$ , C, 35.42; H, 6.27; N, 5.16.

All attempts to crystallise this product from different solvents failed because this product was readily susceptible to aerial oxidation.

**Paper chromatography.**—Paper chromatography was carried out as before in Whatman No. 1 paper using solvent system (a) and ninhydrin solution as spray reagent. The product was revealed as a single spot with R. Glycin.<sup>4,21</sup>

**Acetylation of the amino glucoside.**—Methyl-2-O-mesyl-6-amino-6-deoxy- $\alpha$ -D-glucoside (1.0 gm.) was dissolved in 10 c.c. anhydrous pyridine, cooled to 4° C. and acetic anhydride (5 c.c., cooled to 4° C.) was added with stirring and the entire thing kept at 15° C. for 24 hours. The reaction mixture was evaporated to dryness under reduced pressure (temp. 60° C.), the syrup was poured over ice chips with stirring and extracted with chloroform. The chloroform extract was washed successively with 5% hydrochloric acid solution, saturated sodium bicarbonate solution and distilled water and finally dried over sodium sulphate. The chloroform extract was then concentrated to a syrup and dried under high vacuum. Attempts to crystallise the syrup from different solvent mixtures were unsuccessful. IR spectra: No stretching for free-OH group (3400–3600  $cm^{-1}$ ). max. (2.2%  $CHCl_3$ ): 3130  $cm^{-1}$  (NH), 1740  $cm^{-1}$  and 1230  $cm^{-1}$  (O-Ac), 1720  $cm^{-1}$  (N-Ac).

We are thankful to the authorities and U.S. Department of Agriculture, Foreign Agricultural Research Service, for enabling us to carry out this piece of work under a suitable grant of P.L. 480 fund.

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Jadavpur University,  
Calcutta, November 20, 1967.

S. P. DUTTA.  
A. K. MITRA.

1. Baker, Reist, Spenser and Goodman, *Chem. and Ind.*, London, 1962, p. 1794.
2. — and Haines, *J. Org. Chem.*, 1963, p. 442.
3. Cramer, Otterbach and Springmann, *Chem. Ber.*, 1959, **92**, 384.
4. Frendenberg and Hixon, *Ber.*, 1923, **56**, 2119.
5. Guthrie and Murphy, *J. Chem. Soc.*, 1963, p. 5288.
6. Hanessain and Haskell, *J. Org. Chem.*, 1963, p. 2604.
7. Mitra, Long and Ball, *Ibid.*, 1962, **27**, 1960.
8. Wolfrom, Bernsmann and Horton, *Ibid.*, 1962, p. 4505.

#### SPECIFIC RATES FOR OXIDATION OF LACTATE AND OF LACTIC ACID BY PEROXYDISULPHATE CATALYSED BY SILVER IONS

OXIDATION of lactic acid by peroxydisulphate catalysed by silver ions has been investigated by Bakore and Joshi<sup>1</sup> and also by Mishra and Ghosh.<sup>2</sup> The rate is proportional to the concentration of silver ions and of peroxydisulphate but is independent of the concentration of the lactic acid.

Mishra and Ghosh<sup>2</sup> have observed that an increase of pH increases the rate of oxidation. This suggests that the specific rates of oxidation are different for the undissociated lactic acid and for lactate ions and that the observed rate is the result of two parallel reactions:

- (i) between lactic acid, peroxydisulphate and silver ions;
- (ii) between lactate, peroxydisulphate and silver ions.

An attempt has been made to evaluate the specific rates for lactate and for lactic acid.

Lactic acid and potassium peroxydisulphate of 'Analar' specifications were used. All other chemicals used were chemically pure. The rate of consumption of peroxydisulphate was followed by the procedure used earlier.<sup>1</sup>

If ' $\alpha$ ' be the fraction of the total lactic acid present as lactate, then the fraction of the undissociated lactic acid =  $(1 - \alpha)$ . The observed rate constants, K, can be written as:

$$K = \frac{k_1}{[Ag^+]} = K'(\alpha) + K''(1 - \alpha) = (K' - K'')\alpha + K'' \quad (1)$$

where K' and K'' represent the specific rates for lactate and undissociated lactic acid.

The rate constants K at different values of ' $\alpha$ ' are summarised in Table I. From the data



in Table I and equation (1) the values of ( $K' - K''$ ) and  $K''$  can be obtained by the method of least squares.

TABLE I

$$[S_2O_8] = 1.0 \times 10^{-2} \text{ M} \quad [Ag^+] = 7.70 \times 10^{-4} \text{ M}$$

$$\text{Temp.} = 35^\circ \text{ C.}$$

pH	[L <sup>-</sup> ]	[HL]	$\alpha$	$k_1 \times 10^2$ min. <sup>-1</sup>	$K = k_1 / [Ag^+]$
3.98	0.04	0.03	0.572	1.49	19.35
3.73	0.03	0.04	0.429	1.35	17.53
3.46	0.02	0.05	0.286	1.28	16.49
3.03	0.01	0.06	0.143	1.07	13.90

Calculations show that the value of ( $K' - K''$ ) = 12.29 and  $K''$  = 12.48 litre mole<sup>-1</sup> min.<sup>-1</sup>. This gives  $K' = 24.77$  litre mole<sup>-1</sup> min.<sup>-1</sup>

This shows that the specific rate constant of lactate is nearly twice that of undissociated lactic acid.

Dept. of Chemistry,  
University of Udaipur,  
Udaipur, December 30, 1967.

S. N. JOSHI.  
G. V. BAKORE.

1. Bakore, G. V. and Joshi, S. N. *Z. Physik. Chemie.*, Leipzig, 1965, **229**, 250.
2. Mishra, D. D. and Ghosh, S., *J. Ind. Chem. Soc.*, 1964, **41**, 6.

### SOME NEW POTENTIAL ANTITUBERCULARS: BENZOTHIAZOLYL GUANIDINES

THE antimalarial activity exhibited by some substituted diguanides<sup>1</sup> stimulated the search for other therapeutically useful members of this series and in due course led to the discovery of high antibacterial activity<sup>2</sup> and antitubercular activity,<sup>3</sup> especially among a series of bis-diguanides. Biguanido derivatives<sup>3,4</sup> of diaryl sulphones and sulphides have been found to exhibit antitubercular activity against *Myco. tuberculosis* in *in vitro* tests. In order to determine the degree of molecular complexity necessary for high antimicrobial potency, the stepwise synthesis of polyguanidines was undertaken and it was seen that antitubercular activity was highest in bis-diguanides in which the terminal groups were aryl, alkyl or heterocyclic nucleus.

Recently, Bhargava *et al.*<sup>5,6</sup> have synthesised several N-aryl-N'-2-(substituted)benzothiazolyl guanidines and have shown that the hydrochlorides of these bases are more active against gram-positive bacteria as compared with the gram-negative ones. The above findings led the authors to synthesise some new

N - m - tolyl - N' - 2 - (substituted)benzothiazolyl-N''-alkyl guanidines as potential antituberculars.

In the present communication, 2-amino-(substituted)benzothiazoles<sup>7,8</sup> were condensed with m-tolylisothiocyanate. The resulting benzothiazolylthiocarbamides<sup>9</sup> were desulphurised with yellow lead oxide and various ethanolic alkylamines to give corresponding guanidines.

#### EXPERIMENTAL

N - m - tolyl - N' - 2 - (6-chloro)benzothiazolyl-N''-methyl guanidine.—N-m-tolyl-N'-2-(6-chloro)benzothiazolyl thiocarbamide (3.3 g.), yellow lead oxide (4 g.), ethanolic methyl amine (20 ml.) were heated in a glass autoclave on a water-bath for 3 hours. After cooling, the autoclave was opened carefully, and the product was boiled with ethanol (60 ml.) and filtered hot. The filtrate on cooling gave beautiful crystals. It was recrystallised from ethanol.

Similarly, other N-m-tolyl-N'-2-(substituted)benzothiazolyl-N''-alkyl guanidines have been prepared using different alkylamines. The yields, melting point and analytical data of N - m - tolyl - N' - 2 - (substituted) benzothiazolyl-N''-methyl guanidines and N-m-tolyl-N'-2-(substituted) benzothiazolyl-N''-ethyl guanidines are listed in Tables I and II.

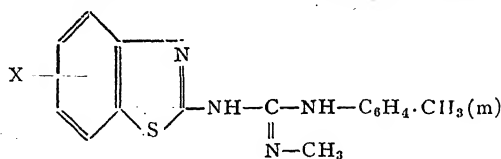
Besides these, the yields, melting points and analytical data of N-m-tolyl-N'-2-(substituted) benzothiazolyl-N''-n-butyl guanidines are as follows:

Substituent -X-	Yield %	M.P. °C.	Elemental analysis, %	
			Found	Calcd.
5-Chloro-	85	202 N, S,	14.98 8.44	15.03 8.59
4-Ethoxy-	80	79 N, S,	14.50 8.22	14.66 8.37

*Pharmacological screening.*—Pharmacological screening of these compounds has shown that N - m - tolyl - N' - 2 - (6 - chloro)benzothiazolyl-N''-methyl guanidine, N-m-tolyl-N'-2-(6-chloro)benzothiazolyl-N''-ethyl guanidine and N-m-tolyl-N'-2-(5-chloro)benzothiazolyl-N''-n-butyl guanidine are active at 100 µg./ml. against *Myco. tuberculosis* (H<sub>37</sub>R). The antibacterial activity of the compound No. 1-12 (Table III) has also been tested against *S. typhi*, *Staph. aureus* and *comma* but the compounds were found to be inactive at 200 µg./ml.

Thanks are due to the authorities of the Banaras Hindu University for providing necessary facilities, the authorities of Central Drug

TABLE I  
N-m-tolyl-N'-2-(substituted) benzothiazolyl-N"-methyl guanidines



Sl.No.	Nature of substituent -X-	Yield %	M.P. °C.	Molecular formula	Nitrogen, %		Sulphur, %	
					Found	Calcd.	Found	Calcd.
1	H	60	183	C <sub>16</sub> H <sub>16</sub> N <sub>4</sub> S	18.81	18.92	10.77	10.81
2	4-Methyl-	83	112	C <sub>17</sub> H <sub>18</sub> N <sub>4</sub> S	18.00	18.06	10.21	10.32
3	6-Methyl-	50	179	C <sub>17</sub> H <sub>18</sub> N <sub>4</sub> S	18.10	18.06	10.30	10.32
4	4-Chloro-	70	151	C <sub>16</sub> H <sub>15</sub> N <sub>4</sub> SCl	16.88	16.94	9.60	9.68
5	5-Chloro-	90	186	C <sub>16</sub> H <sub>15</sub> N <sub>4</sub> SCl	16.90	16.94	9.69	9.68
6	6-Chloro-	60	111	C <sub>16</sub> H <sub>15</sub> N <sub>4</sub> SCl	16.91	16.94	9.66	9.68
7	4-Methoxy-	65	165	C <sub>17</sub> H <sub>18</sub> N <sub>4</sub> SO	17.01	17.18	9.79	9.81
8	4-Ethoxy-	85	107	C <sub>18</sub> H <sub>20</sub> N <sub>4</sub> SO	16.36	16.47	9.37	9.41
9	6-Ethoxy-	80	136	C <sub>18</sub> H <sub>20</sub> N <sub>4</sub> SO	16.44	16.47	9.40	9.41
10	6-Bromo-	75	135	C <sub>16</sub> H <sub>15</sub> N <sub>4</sub> SBBr	14.87	14.94	8.47	8.53

TABLE II  
N-m-tolyl-N'-2-(substituted) benzothiazolyl-N"-ethyl guanidines

Sl. No.	Nature of substituent -X-	Yield %	M.P. °C.	Molecular formula	Nitrogen, %		Sulphur, %	
					Found	Calcd.	Found	Calcd.
1	H	80	98	C <sub>17</sub> H <sub>18</sub> N <sub>4</sub> S	18.00	18.06	10.20	10.37
2	4-Methyl-	55	230	C <sub>18</sub> H <sub>20</sub> N <sub>4</sub> S	17.13	17.28	9.77	9.88
3	5-Methyl-	50	161	C <sub>18</sub> H <sub>20</sub> N <sub>4</sub> S	17.05	17.28	9.80	9.88
4	6-Methyl-	75	104	C <sub>18</sub> H <sub>20</sub> N <sub>4</sub> S	17.14	17.28	9.81	9.88
5	4-Chloro-	45	196	C <sub>17</sub> H <sub>17</sub> N <sub>4</sub> SCl	16.15	16.26	9.17	9.28
6	5-Chloro-	50	197	C <sub>17</sub> H <sub>17</sub> N <sub>4</sub> SCl	16.20	16.26	9.21	9.28
7	6-Chloro-	70	90	C <sub>17</sub> H <sub>17</sub> N <sub>4</sub> SCl	16.13	16.26	9.19	9.28
8	4-Methoxy-	75	132	C <sub>18</sub> H <sub>20</sub> N <sub>4</sub> SO	16.36	16.47	9.30	9.41
9	4-Ethoxy-	65	110	C <sub>19</sub> H <sub>22</sub> N <sub>4</sub> SO	15.77	15.82	9.00	9.04
10	6-Ethoxy-	60	106	C <sub>19</sub> H <sub>20</sub> N <sub>4</sub> SO	15.73	15.82	9.01	9.04
11	6-Bromo-	45	215	C <sub>17</sub> H <sub>17</sub> N <sub>4</sub> SBBr	14.31	14.40	8.10	8.23

TABLE III  
Antitubercular activity of N-m-tolyl-N'-2-(substituted) benzothiazolyl-N"-alkyl guanidines

Sl. No.	-X-	Alkyl group	Myco. tuberculosis (H <sub>37</sub> R <sub>p</sub> )	
			Activity in µg./ml.	
1	6-Chloro-	Methyl.	Active at 100 µg./ml.	
2	4-Chloro-	"	Inactive at 200 µg./ml.	
3	4-Methyl-	"	"	
4	4-Methoxy-	"	"	
5	6-Ethoxy-	"	"	
6	6-Chloro-	Ethyl	Active at 100 µg./ml.	
7	5-Chloro-	"	Inactive at 200 µg./ml.	
8	6-Methyl-	"	"	
9	4-Ethoxy-	"	"	
10	6-Ethoxy-	"	"	
11	5-Chloro-	n-Butyl	Active at 100 µg./ml.	
12	4-Ethoxy-	"	Inactive at 200 µg./ml.	

Streptomycin active at 1 v/ml. against *Myc. tuberculosis* (H<sub>37</sub>R<sub>p</sub>)

Penicillin G. " 4 v/ml. against *Staph. aureus*

Chloromycetin " 4 v/ml. against *S. typhi*

I.N.H. " 0.4 v/ml. against *Myc. tuberculosis* (H<sub>37</sub>R<sub>p</sub>)

Research Institute, Lucknow, for carrying out the pharmacological screening and also to the University Grants Commission, New Delhi, for the award of a Junior Research Fellowship to one of us (M. R. C.).

Dept. of Chemistry, P. N. BHARGAVA.  
College of Science, M. R. CHAURASIA.  
Banaras Hindu University,  
Varanasi-5, February 12, 1968.

1. Curd, F. H. S. and Rose, F. L., *J. Chem. Soc.*, 1916, p. 729.
2. Rose, F. L. and Swain, G., *Ibid.*, 1956, p. 4422.
3. Jayasimha, B. N., Bhattacharya, S. C. and Guha, P. C., *Curr. Sci.*, 1951, 20, 158.
4. Sirsi, M., Jayasimha, B. N. and Iyengar, J. R., *Ibid.*, 1951, 20, 237.
5. Bhargava, P. N. and Devi, K. S., *J. Ind. Chem. Soc.*, 1963, 40, 868.
6. — and Ram, P., *Ibid.*, 1960, 4, 95.
7. Hagerschoff, *Ber. dtsh. Chem. Ges.*, 1903, 36, 3221.
8. Bhargava, P. N. and Baliga, B. T., *J. Ind. Chem. Soc.*, 1958, 35, 807.
9. — and Ram, P., *Ind. J. Appl. Chem.*, 1961, 24, 181.

# A RATIO METHOD AS A SUBSTITUTE FOR THE CURVE-MATCHING PROCEDURE FOR SOLVING CERTAIN TYPES OF PROBLEMS

THE curve-matching procedure is commonly employed for computing parameters in certain types of experimental work, as in ground-water hydraulics (based on principles similar to conduction of heat in solids), where, the parameters of a "leaky aquifer",  $T$  (Transmissivity),  $S$  (Storativity) and  $B$  (a function of leakance) are computed with the values,  $s$  (drawdown),  $t$  (time),  $r$  (radius of the point of observation) and  $Q$  (rate of discharge), experimentally observed during the "pumping test". For the particular experiment,  $s$  and  $t$  are variables and  $r$  and  $Q$  are constants.

From theory (Hantush<sup>1</sup>) it is known that:

$$s = \frac{Q}{4\pi T} W(u, B) \quad (1)$$

$$W(u, B) = \int_u^\infty e^{-y - u^2/4y} \cdot \frac{dy}{y} \quad (2)$$

$$u = \frac{r^2 S}{4Tt} \quad (3)$$

$$B = \frac{r}{\sqrt{Tb'K'}} \quad (4)$$

It is not possible to directly solve for  $T$ ,  $S$  and  $B$  from (1) and (3) because  $T$  occurs in the argument of the function and again as a divisor of the exponential integral. Therefore, the curve-matching procedure, originally devised by Theis,<sup>2</sup> is commonly employed for solving for  $T$ ,  $S$  and  $B$  (Walton<sup>3</sup>).

For purposes of curve-matching, a family of type-curves is prepared on a transparent, double-logarithmic paper, showing the variation of  $W(u, B)$  against  $1/u$ , using the values tabulated by Hantush<sup>4</sup> (Fig. 1).

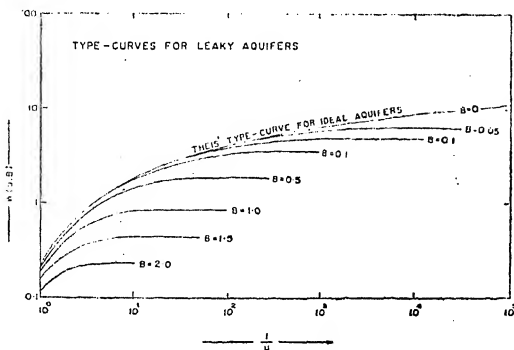


FIG. 1

The Ratio Method described below, advantageously dispenses with the curve-matching procedure.

Consider three points  $[u_0, W(u_0, B)]$ ,  $[u_1, W(u_1, B)]$  and  $[u_2, W(u_2, B)]$ , on any one of the members of the type-curve family. Then, the four ratios,  $u_0/u_1$ ,  $u_0/u_2$ ,  $W(u_0, B)/W(u_1, B)$  and  $W(u_0, B)/W(u_2, B)$  have fixed values. Conversely, if the four ratios should have fixed values, then, each of the factors,  $u_0$ ,  $u_1$ ,  $u_2$ ,  $W(u_0, B)$ , etc., and the value  $B$  are uniquely determined. Practically, therefore, it is possible to assign convenient fixed values to the ratios  $u_0/u_1$  and  $u_0/u_2$  and prepare a chart, showing the variation of one or more of the factors in relation to the other two ratios, namely,  $W(u_0, B)/W(u_1, B)$  and  $W(u_0, B)/W(u_2, B)$ . Thus, Figs. 2A and 2B depict on a simple, square paper, the variation of  $B$ ,  $u_0$  and  $W(u_0, B)$ , for the particular condition where  $u_0/u_1 = 2$  and  $u_0/u_2 = 100$ .

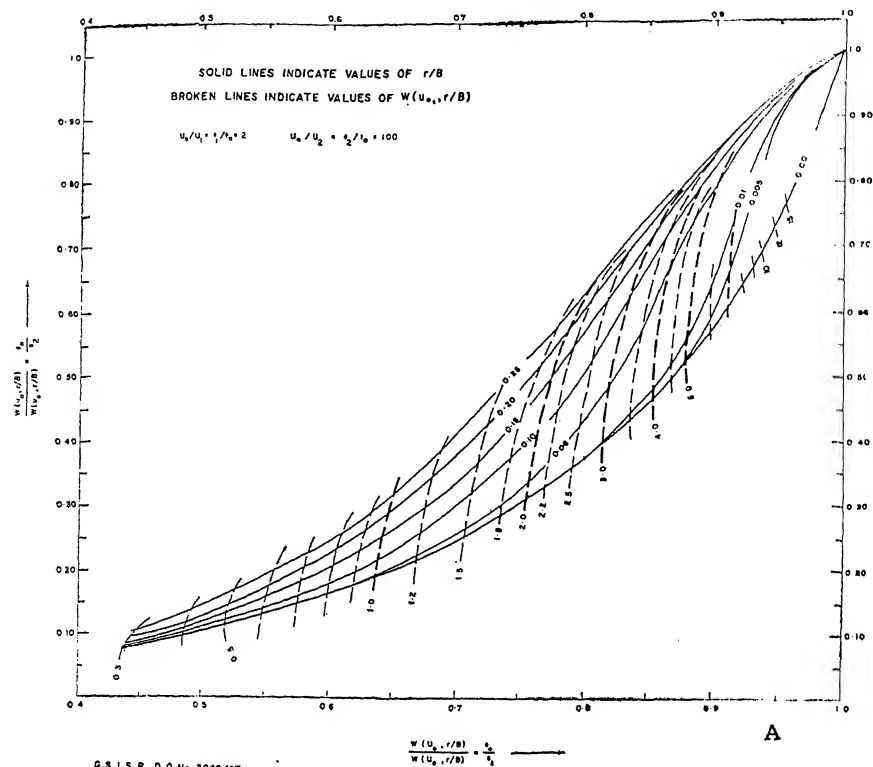
Moreover, by a rearrangement of (1) and (3),

$$\begin{aligned} \frac{W(u_0, B)}{W(u_1, B)} &= \frac{s_0}{s_1} & \frac{W(u_0, B)}{W(u_2, B)} &= \frac{s_0}{s_2} \\ \frac{u_0}{u_1} &= \frac{t_1}{t_0} & \frac{u_0}{u_2} &= \frac{t_2}{t_0} \end{aligned}$$

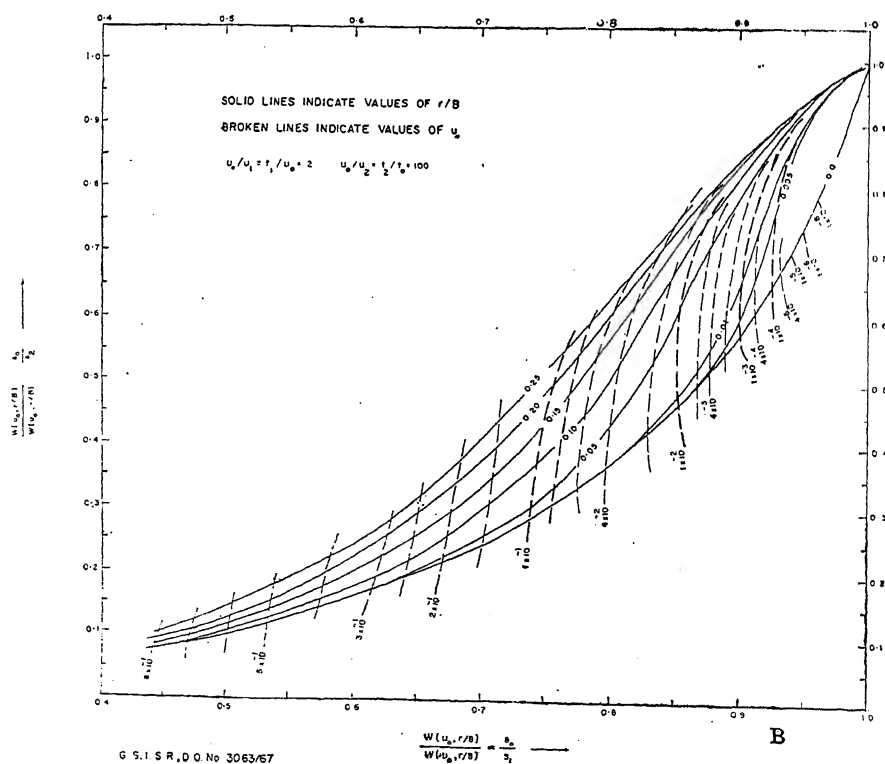
Therefore, considering three pairs of values of experimental data  $(t_0, s_0)$ ,  $(t_1, s_1)$  and  $(t_2, s_2)$ , such that  $t_1 = 2t_0$  and  $t_2 = 100t_0$ , it is possible to determine the ratios,  $s_0/s_1$   $[= W(u_0, B)/W(u_1, B)]$  and  $s_0/s_2$   $[= W(u_0, B)/W(u_2, B)]$ , using which, the values of  $u_0$ ,  $W(u_0, B)$  and  $B$  could be extrapolated from Figs. 2A and 2B. These, along with  $t_0$  and  $s_0$  could be substituted in (1) and (3) to determine  $T$  and  $S$ .

The particular condition,  $B = 0$ , represented by the limiting curve in Fig. 1, is the Theis' type-curve for ideal aquifers. In this particular case, the Ratio Method becomes simpler and solution for  $T$  and  $S$  is possible by considering the ratio relationships existing between any two points  $(t_0, s_0)$  and  $(t_1, s_1)$ , as demonstrated by Jaeger<sup>5</sup> and Narasimhan.<sup>6</sup>

The detailed charts, based on the Ratio Method, to analyse different types of aquifers, forms the subject of a separate paper (Narasimhan<sup>7</sup>). This communication, however, seeks to bring out the basic principle of the method, which might have useful application in other branches of science.



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FIG. 2

Geological Survey of T. N. NARASIMHAN.  
India, 3-6-291, Hyderguda,  
Hyderabad-1, February 19, 1968.

1. Hantush, M. S., "Analysis of data from pumping tests in leaky aquifers," *Trans. Am. Geophys. Union*, 1956, **37**, 702.
2. Theis, C. V., "The relation between the lowering of the piezometric surface and the rate of duration of discharge of a well using ground water storage," *Ibid.* 1935, **16**, 519.
3. Walton, W. C., "Leaky artesian aquifer conditions in Illinois," *Report of Investigation*, 39, *Ill. State Water Surv.*, 1960.
4. Hantush, M. S., *Table of the Function W(u, B)*, Prof. Paper 104, New Mexico Inst. of Tech., 1961.
5. Jaeger, J. C., "The analysis of aquifer test data or thermal conductivity measurements," *J. Geophys. Res.*, 1959, **64**, 561.
6. Narasimhan, T. N., "An alternative method for computing aquifer constants using Theis' non-equilibrium formula," *Jour. Ind. Geophys. Union*, 1966, **3**, 83.
7. —, "Ratio method for computing the characteristics of ideal, leaky and bounded aquifers," *Bull. Int. Ass. Sci. Hydrology*, 1968 (In press).

## EFFECT OF SULPHUR ON BACTERIAL NODULATION OF GROUNDNUT ROOTS

THE fixation of elemental nitrogen by the symbiotic nodule bacteria needs no emphasis. It has long been recognized that certain crops such as clovers, alfalfa, peas and other legumes improve the soil in some way, making it possible to get higher yields of cereals after these crops. Lyon and Bizzell<sup>1</sup> in a ten-year experiment at Ithaka, New York, found that the amounts of nitrogen fixed in pounds per acre per year were 251, 168 and 105 by nodule bacteria of alfalfa, sweet clover and soyabean, respectively.

The nodulation in legumes was stimulated by fertilizing the soil with sulphur and its compounds as was observed by several workers.<sup>2-8</sup> Tacheuchi<sup>9</sup> reported that higher dose of sulphur and its compounds gave a decreasing effect upon the number of nodules.

Groundnut plants (*Arachis hypogaea* L.) T, 32 were raised in washed silica sand in pots. The plants were supplied with complete nutrient solution, the formula for nutrient solution is given in Table I (Tisdale et al.<sup>10</sup>) and distilled water for irrigation. All the pots received 5 ppm iron tartarate, 2 ppm manganese chloride, 3 ppm boric acid and 1.4 ppm molybdic acid. pH of the final solution was adjusted to 6.5 by adding N/10 NaOH. Nutrient solution was added at the rate of 250 c.c. per pot on alternate days. At periodical intervals, the whole plant was pulled off with the help of distilled water running through rubber tube in the root zone, taking precaution not to injure the root nodules. The nodules were then separated and counted.

TABLE I  
Composition of nutrient solution and compound of sulphur used

Treat- ment	Doses of S ppm	Gm. of salt per litre of water					
		KNO <sub>3</sub>	KCl	K <sub>2</sub> SO <sub>4</sub>	CaCl <sub>2</sub>	MgCl <sub>2</sub>	Ca (HPO <sub>4</sub> ) <sub>2</sub> · H <sub>2</sub> O
S <sub>0</sub>	0	0.505	0.220	0.0000	0.33	0.19	0.125
S <sub>1</sub>	3	0.505	0.215	0.0054	0.33	0.19	0.125
S <sub>2</sub>	9	0.505	0.204	0.0163	0.33	0.19	0.125
S <sub>3</sub>	27	0.505	0.171	0.0489	0.33	0.19	0.125
S <sub>4</sub>	81	0.505	0.073	0.1468	0.33	0.19	0.125

An observation of the data in Table II reveals that number of nodules per plant at the time of harvest increased from 9.3 to 121.3 with the enhancement of sulphur concentration from 0 to 9 ppm in the nutrient solution. Further increase in sulphur concentration upto 81 ppm showed a corresponding decrease in the number of nodules per plant. The treatments showed significant difference and treatments S<sub>3</sub> and S<sub>4</sub> were of equal effect.

TABLE II  
Effect of sulphur concentrations on the number of nodules per plant of groundnut

S. No.	Treat- ment	Doses of S ppm	Age of crop in days							Mean	Index	Weight of root at 160 days per plant
			20	40	60	80	100	120	140			
1	S <sub>0</sub>	0	0.4	1.8	3.3	4.7	6.3	8.0	9.3	4.8	100	0.467
2	S <sub>1</sub>	3	0.5	5.0	25.0	29.3	35.3	40.0	51.0	26.6	545	0.467
3	S <sub>2</sub>	9	5.6	23.7	60.6	78.3	108.3	118.7	121.3	73.1	1304	1.050
4	S <sub>3</sub>	27	2.9	20.0	51.3	67.3	73.3	93.3	103.3	58.8	1111	1.167
5	S <sub>4</sub>	81	2.4	11.3	33.7	47.0	60.0	78.3	85.3	45.4	917	1.133
Mean			2.4	12.4	34.8	45.3	55.6	67.7	74.0	..	..	0.857
C.D.			..	..	..	..	..	..	..	18.60	..	..

The reduction in nodulation due to sulphur deficiency corroborates with the findings of Gaw and Soong,<sup>7</sup> Ivanoff<sup>8</sup> and Bledsoe and Harris.<sup>6</sup> This decrease may be attributed to the deficiency of sulphur, which is a nutrient element, and restricted supply of sulphur-containing plant proteins which are essential for the multiplication and growth of symbiotic bacteria. The decrease in root size may be a factor for the reduction in nodulation, but the effect of deficiency appears to be more marked on nodulation as compared to size (weight) of roots.

The decrease in number of nodules in treatments with 27 and 81 ppm of S may be due to inhibitory effect of sulphate at higher concentrations. A similar effect was also observed by Tacheuchi.<sup>9</sup>

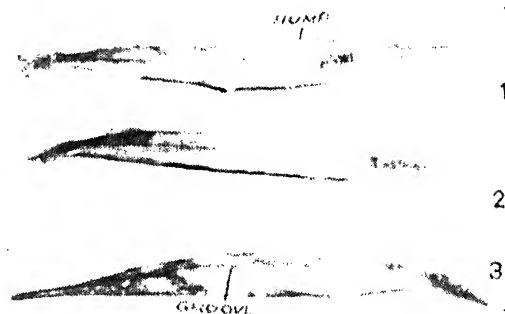
Dept. of Agric. Chem. & S. P. BHARDWAJ.  
Soil Science, A. N. PATHAK.  
Govt. Agric. College, Kanpur (U.P.),  
January 30, 1968.

1. Lyon, T. L. and Bizzell, A. J., *J. Am. Soc. Agron.*, 1934, **26**, 651.
2. Miller, H. G., *J. Agric. Res.*, 1921, **22**, 101.
3. Neller, J. R., *Wash. Agric. Exp. Stat. Bull.*, 1925, **190**, 5.
4. Anderson, A. J. and Spencer, O., *Nature*, 1949, **164**, 273.
5. Ashford, K. and Bolton, J. L., *Canad. J. Plant Sci.*, 1961, **40**, 574.
6. Bledsoe, R. W. and Harris, A. N., *Plant Physiol.*, 1949, **25**, 63.
7. Gaw, H. Z. and Soong, P. N., *J. Am. Soc. Agron.*, 1942, **34**, 100.
8. Ivanoff, S. S., *Plant Physiol.*, 1948, **23**, 162.
9. Tacheuchi, T., *Ann. Bull. Imp. Inst. Tokyo*, 1946, **14**, 289.
10. Tisdale, S. L., Davis, R. L., Kingsley, A. F. and Mertz, E. R., *J. Am. Soc. Agron.*, 1950, **42**, 221.

#### SEXUAL DIMORPHISM IN THE GAR FISH, *XENENTODON CANCELA*

DAY<sup>1</sup> describing *Belone cancela* (*Xenentodon cancela*) states, "There is a variety at Hardwar and in Central Provinces, having a hump along the first part of its back, sometimes continued as an elevated ridge as far as the origin of the dorsal fin". In the present study, several hundred specimens were examined from the collections made at Bhopal, Jabalpur, Shivpuri, Gwalior, Dehradun, Muzaffarnagar, Allahabad and the local lakes (Ramgarh and Mahesra) and the rivers (Rapti and Rohin). A good percentage of them was with humped back (Fig. 1) as mentioned above. The hump is darker in colour than the adjoining body

surface and its ratio with the head-length determined from random sampling is 1.0:2.1. The examination of gonads reveals that the hump-backed specimens are males. On the contrary, females have flat surface with a shallow groove in the corresponding region (Figs. 2 and 3) without any colour differentiation. Thus it is clear that *Xenentodon cancela*



FIGS. 1-3. Fig. 1. *Xenentodon cancela*, male with hump. Fig. 2. *Xenentodon cancela*, male without hump. Fig. 3. *Xenentodon cancela*, female showing groove.

exhibits sexual dimorphism and the hump is not a characteristic feature of a different variety as suggested by Day but a male character like that of a pink salmon, *Oncorhynchus gorbuscha* (Norman and Greenwood<sup>2</sup>). The male and female ratio is approximately 1:2. Further, certain male specimens show more prominent pink colour on the ventral surface of the lower jaw than those of the females. Whether the factors responsible for such a colouration are ecological or due to hormonal activity is under investigation.

Dept. of Zoology, KRISHNA SWARUP,  
University of Gorakhpur,  
Gorakhpur, January 12, 1968.

1. Day, F., *Fishes of India*, William Dawson, London, 1878, p. 1.
2. Norman, J. R. and Greenwood, P. H., *A History of Fishes*, Ernest Benn, London, 1963, p. 1.

#### FOLIAR SCLEREIDS IN SOME SPECIES OF *LIMONIUM* (PLUMBAGINACEAE)

RECENT studies have stressed the importance of sclereid pattern in anatomical taxonomy in many seed plants. During the studies on the comparative morphology of foliar sclereids in several genera, a unique pattern of foliar sclereid distribution in certain species of *Limonium* of significant morphological interest was observed.

# MATERIALS EXAMINED

*Limonium auriculifolium* (Vahl) Druce, Kheria, s.n. (CAL.); *L. axillare* (Pork.) O. Kuntze, J. Ellerton 436 (CAL.); *L. cabulicum* (Bong.) O. Kuntze, Afghanistan, Griffith 4171 (CAL.); Himalaya, H. Collet 37 (CAL.); Hazara, Stewart 401 (CAL.); F.P. Maynard 6 (CAL.); Beluch-Afghan, Boundary Commission, 9 (CAL.); *L. griffithii* (Antch. et Hemsl.) O. Kuntze, J. E. T. Aitchison 439 (CAL.); Beluchistan, J. H. Lace 3696 (CAL.); Panjkora valley, Gataere s.n. (CAL.); Harris s.n. (CAL.); N.-W. Himalaya, Inayat 19904 (CAL.); Black Mountain Exped., J. E. Duthie 7523 (CAL.); *L. leptostachyum* (Bong.) O. Kuntze, Afghanistan, J. E. T. Aitchison 1076 (CAL.); *L. macrorrhabdon* (Bong.) O. Kuntze, Beluchistan, Stocks s.n. (CAL.); Bombay, N. Dalzell s.n. (CAL.); Beluch-Afghan, Boundary Commission, F. P. Maynard 8 (CAL.); Waziristan-Bardwand, Harukh, s.n. (CAL.); *L. reniforme* (Griseb.) Lince, Afghanistan, J. E. T. Aitchison 744 (CAL.); *L. spicatum* (Willd.) O. Kuntze, Peshawar, J. H. Lace, 3572 (CAL.); Beluchistan, O. T. Duke s.n. (CAL.); Bombay, N. Dalzell, s.n. (CAL.); Afghanistan, s.n. (CAL.); Afghanistan, Griffith, s.n. (CAL.); Afghanistan, J. E. T. Aitchison 291 (CAL.); *L. stocksii* (Boiss.) O. Kuntze, Porbandar-Saurashtra, B. Saftui, 17-2-1963, 2473 (CAL.); Du Island, T. A. Rao, 27-11-1962, 1963 (CAL.); Okha to Armada, T. A. Rao, 18-11-1962, 1222 and 1921 (CAL.); Jafarabad, T. A. Rao, 10-10-1964, 2201 (CAL.); *L. suffruticosum* (L.) O. Kuntze, Afghanistan, J. E. T. Aitchison, 65 and 780 (CAL.).

## GENERAL DISTRIBUTION

Among the eleven species of *Limonium* investigated in the present study, sclereids were encountered only in the following six species: *L. auriculifolium*, *L. axillare*, *L. cabulicum*, *L. griffithii*, *L. suffruticosum* and *L. stocksii*. The leaves of these species are more or less oblong spatulate and show a pair or three to five veins which extending into the lamina thus forming palmate reticulate venation pattern which in turn results in the formation of a number of small veinlet-endings. In the leaves the pattern of sclereid orientation inside the lamina exhibits a distinct trend which is of morphological interest. They are found in close association with major veins and veinlet-endings. Laminae sclereids and their distribution closely follow the venation pattern. At the base of the

lamina sclereidial concretions called sclerocysts<sup>1</sup> are often found encasing a portion of the prominent 2 to 3 lateral veins. Along the expanded middle portion of the lamina there is the concurrent occurrence of broken cysts or loosely disposed sclereidial groupings associated with smaller veins and veinlet-endings. Further, in the laminar areas adjoining the apical region, the sclereids exhibit distinct terminal or subterminal positions with reference to veinlet-endings. Transections of the lamina at various levels clearly show the relationship between the veins and sclereids. Thus the sclereids exhibit different patterns with regards to their distribution along with the veins. Some leaves, which are devoid of sclereids, have lobed tracheoids at their vein endings.

## SCLEREID TYPES

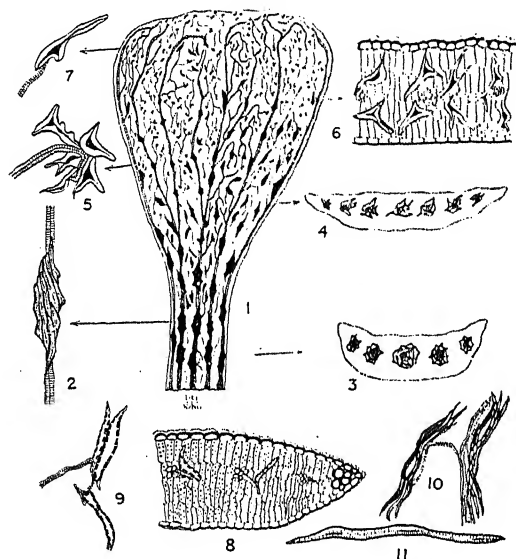
The present study has revealed the presence of sclereids of two types:

*Type I*.--Filiform sclereids of limited length closely juxtaposed to form sclerocysts associated with the main and secondary veins as well as veinlet-endings. They form discrete concretions, sometimes loosely or compactly knit around a portion of the vein or vein-endings. This is observed in *Limonium cabulicum*. In transections the sclerocysts are in abundance at the basal region and in the expanded lamina they are smaller and less dense. Almost all the veins are invariably attached with a number of cysts. Sometimes at the terminal regions of the veins, tracheoid idioblasts are observed (Figs. 8-11).

*Type II*.--Fusiform polymorphic sclereids of varied subtypes with tapering ends and frequently branched at the tips. A noteworthy feature of morphological interest is the formation of discrete sclereidial concretions at the basal region enclosing a portion of the lateral veins. In the middle and apical regions of the lamina the sclereidial concretions are broken up or loosely knit and ultimately one or two may be present at the veinlet-ends. This feature is seen in the leaves of *L. auriculifolium*, *L. axillare* and *L. stocksii*. The fusoid sclereids are forked or unforked and have distinct spicules especially when they are clustered. Their terminal and subterminal relationships are clear in the apical region of the lamina.

In transections of the leaves of *L. axillare* the sclerocysts are very conspicuous at the basal area. They are composed of fusoid cells

with bulged median portions and tapering ends and exhibit a firm interlocking arrangement (Figs. 1-7). In the broad lamina the cysts become less conspicuous and ultimately resolve into single or doubles at the veinlet-endings. The occurrence only at the veinlet-endings, a solitary cyst or common cysts for two or three veinlet-endings have been noticed as in *Memecylon parvifolium* Thw.<sup>1</sup> In *L. stocksii* sclerocysts are present at the basal portions of the main veins and also in the intervening spaces between them. This feature continues upwards and ultimately the sclerocysts are reduced to a few sclereids.



FIGS. 1-11. Fig. 1. Cleared leaf of *Limonium axillaris*,  $\times 3$ . Fig. 2. Enlarged basal sclerocyst,  $\times 5$ . Fig. 3. T.S. basal area of the lamina showing cysts,  $\times 15$ . Fig. 4. T.S. of mid-portion of lamina showing broken cysts,  $\times 15$ . Fig. 5. Enlarged broken cyst,  $\times 5$ . Fig. 6. T.S. of apical portion of lamina showing orientation of sclereids,  $\times 15$ . Fig. 7. Single terminal sclereid at veinlet-end,  $\times 15$ . Fig. 8. T.S. *L. cabulicum* showing sclereids,  $\times 15$ . Fig. 9. Tracheoid idioblasts at the veinlet-ends,  $\times 25$ . Fig. 10. Loosely knit sclereidial concretions at the veinlet-ends,  $\times 25$ . Fig. 11. A filiform sclereid,  $\times 50$ .

In the leaves of *L. suffruticosum* and *L. griffithii* sclerocysts are absent but frequently sclereids appear in twos or threes at the veinlet-ends having a terminal or subterminal position. Sclereids of *L. suffruticosum* have broad lumen and striated secondary walls, on the other hand, they are narrow and non-striated in *L. griffithii*.

The pattern of distribution of foliar sclereids in the leaves of certain species of *Limonium*

is of significant morphological interest: (a) the pattern varies from simple, oval or spheroidal sclerocysts at the base to many intermediate stages in the middle and finally to single or two individuals at the apical regions, (b) uniform distribution of terminal and subterminal sclereids and (c) the existence of filiform sclereids in close association with the prominent primary veins, secondary veins and veinlet-endings.

Thanks are due to Dr. S. K. Mukherjee, Keeper, Central National Herbarium, for the loan of specimens, Dr. H. Santapau for encouragement and Dr. K. Subramanyam for going through this manuscript.

Botanical Survey of India, T. ANANDA RAO.  
Calcutta, March 19, 1968. G. C. DAS.

1. Rao, T. A., *Phytomorphology*, 1957, 7, 306.

#### NEW RECORDS OF SOME PARASITES AND PREDATORS OF THE RICE MEALY-BUG, *RIPERSIA ORYZAE* GREEN (HEMIPTERA: PSEUDOCOCCIDAE)\*

The rice mealy-bug, *Ripersia oryzae* Green, is a pest of paddy in many parts of India. Although generally considered of minor importance, it sometimes takes a heavy toll of the crop. Certain conditions like drought, bad drainage and poor soil seem to encourage development of infestations.

Infestation generally starts under the leaf-sheaths and spreads rapidly between the stem and the leaf-sheaths. The bugs suck the sap from the succulent stem under the outer sheathing leaves, thereby weakening the growth of the plant. The affected plants appear stunted. In cases of severe infestation, the plants look scorched and do not produce ears.

A survey for rice pests and their natural enemies was carried out by the Indian Station of the Commonwealth Institute of Biological Control from 1961 to 1964 under a U.S. PL-480 grant. This project was meant primarily as a survey of stem-borers and their natural enemies; however, incidentally, the following study on the mealy-bug was also made:

Observations on the life-history of *R. oryzae*, carried out in the laboratory at Chandanagar (West Bengal) in 1963, indicated that they are very prolific, individual females laying up to 350 eggs. Eggs usually hatched in less than 24 hours, and the nymphal period lasted 3 to 4 weeks during July, August and



TABLE I  
Parasites recorded from *R. oryzae*

Order/Family	Parasites	Locality of occurrence
<b>HYMENOPTERA</b>		
Ceraphronidae	<i>Ceraphron</i> sp.	Kumarpara (Orissa)
Encyrtidae	<i>Adelencyrtus</i> sp.	Kashipur, Triveni (West Bengal)
	<i>Cheiloneurus</i> sp.	Kashipur (West Bengal)
	<i>Doliphoceros</i> sp.	Jagmara (Orissa), Kivaloor, Poosangudi (Madras State)
	<i>Gyranusa</i> sp.	Pundooah (West Bengal)
	? <i>Gyranusa</i> sp.	Kashipur (West Bengal)
	<i>Mayridia</i> sp.	do.
	Mirini (Genus unknown)	do.
	<i>Parasyrphophagus</i> sp.	Kivaloor (Madras State), Kumarpara (Orissa), Kashipur, Pundooah (West Bengal)
	<i>Xanthoencyrtus</i> sp.	Kashipur, Triveni (West Bengal)
	do. (possibly <i>fullerayi</i> Timb.)	Kashipur (West Bengal)
Eulophidae	<i>Aprostocetus</i> sp.	Kumarpara, Jagmara (Orissa)
	<i>Chrysocharis</i> sp.	Pundooah (West Bengal)
	<i>Derostenus</i> sp.	do.
	<i>Tetrastichus</i> sp.	Kumarpara (Orissa)
Mymaridae	<i>Lymnecyon</i> sp.	Jagmara (Orissa)
Pteromalidae	<i>Callitula</i> sp.	Kumarpara (Orissa)
	Diparini sp. Genus ?	Poosangudi (Madras State)
Thysanidae	<i>Thysanus</i> sp.	Pundooah (West Bengal)

TABLE II  
Predators recorded from *R. oryzae*

Order and family	Name of the predator	Locality of occurrence
Col. : Coccinellidae	<i>Pullus</i> sp.	Poosangudi (Madras State), Triveni (West Bengal)
Dip. : Cecidomyiidae	Genus sp. ?	Poosangudi (Madras State)
Dip. : Chloropidae	<i>Anatrichus pygmaeus</i> Lamb.	Kivaloor, Poosangudi (Madras State), Baidyabati (West Bengal)
	<i>Mesochorus ensifer</i> (Thompson)	Triveni (West Bengal)
Dip. : Drosophilidae	<i>Gitona perspicax</i> (Knal)	Baidyabati, Pundooah and Triveni (West Bengal)

September. Mature females can survive for long periods without food, and starvation does not appear to impair their egg-laying capacity. During laboratory rearing, there were many instances of females laying eggs for 3 to 4 weeks without feeding.

Ramakrishna Ayyar<sup>1</sup> mentioned unidentified Chalcidoids, the Drosophilid *Gitona* (= *Gitonides*) *perspicax* (Knab), the Agromyzid, *Leucopis luteicornis* Malloch and the Coccinellid, *Scymnus* sp., as natural enemies of *R. oryzae* in South India. No other published records of natural enemies of this species are available. During the present investigation, collections of infested paddy plants were made from the areas in and around Bhubaneswar (Orissa) in November-December 1963, around Tiruvavur (Madras State) in November-December 1963 and again in February 1964, and in Hooghly and Murshidabad (West

Bengal) in July 1963. Small portions of paddy stems with heavy mealy-bug infestation were placed individually in glass tubes and the following 19 species of hymenopterous parasites, all of which are new records, were reared. In addition to these, five predators have also been recorded during the present survey.

Except for *Adelencyrtus* sp., *Doliphoceros* sp., *Parasyrphophagus* sp., *Xanthoencyrtus* spp. and *Gyranusa* sp., which are primary parasites, the status of other parasites as primary or secondary or as both remains to be studied.

*G. perspicax*, *M. ensifer* and *A. pygmaeus* were predators in their larval stages while both larvae and adults of *Pullus* sp. attacked the mealy-bug.

The author wishes to record his gratitude to Dr. V. P. Rao, Entomologist-in-charge, CIBC, Bangalore, for all the encouragement he had given in this work. He is thankful to his

colleagues Messrs. V. R. Phalak and M. K. Rajendran for their assistance. The author is also grateful to the United States Department of Agriculture and the Commonwealth Institute of Entomology, for having identified the parasites and predators.

Indian Station, T. M. MANJUNATH.  
Commonwealth Institute of  
Biological Control,  
Bangalore, India, February 14, 1968.

\* This research has been financed in part by a grant made by the United States Department of Agriculture under PL-480.

1. Ramakrishna Ayyar. T. V., *J. Mysore Agric. Exp. Un.*, 1939, 17 (4), 179.

### COLCHICINE-INDUCED MUTANT IN COTTON (*GOSSYPIUM HIRSUTUM*, L.)

COLCHICINE is known more familiarly as a polyploidising agent than a mutagenic (gene mutation) agent. However, a few reports on *sorghum*<sup>1-6</sup> and on flax<sup>7</sup> have given an indication to the fact that colchicine can also cause chimeral sector, somatic reduction besides gene mutations. The results reported here, however, supplement to the fact that colchicine may also induce gene mutations.

*Gossypium hirsutum* L. variety, *Laxmi* was treated with the aqueous solution of Colchicine of 0.002, 0.005, 0.1 and 0.2% concentrations in 1962 with an idea of inducing polyploidy. Plumules were treated for varying periods like  $\frac{1}{2}$ , 1,  $1\frac{1}{2}$ , 2,  $2\frac{1}{2}$ , 3, 5, 7 and 9 hours by covering the apical region with a piece of cotton lint dipped in respective concentrations. Cotton lint was kept moist by adding a few drops of the solution every now and then.

Seedlings under treatment with 0.1 and 0.2% solution for 3 hours and more died after 2-3 days. The concentrations of 0.005 and 0.002% appeared to be tolerable as the seedlings survived the treatment. No morphological varia-

tions could be found with the surviving plants, except with one treated with 0.002% concentration in which the seeds were 'naked' instead of being fuzzy as in the parental variety *Laxmi*. Further, this variant bred true for this character in subsequent generations. The naked seed, however, had a few hair-like structures towards the micropylar end.

From amongst the progeny of the naked seeded mutant, 2 plants were found whose further progenies in turn, exhibited variation in respect of certain economic characters as shown in Table I.

Cytological studies revealed no variation in respect of chromosome number and structure which suggests the genic nature of the alteration of naked character of the seed.

Naked seed in cotton is advantageous as a better cattle feed, in sowing operations and as regard its better germinating capacity.

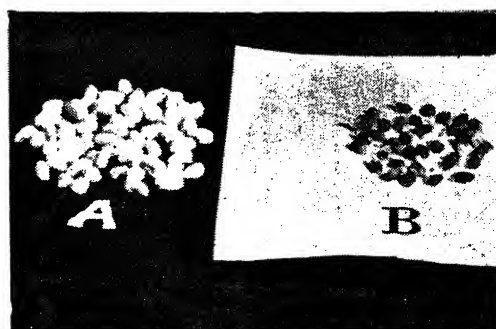


FIG. 1. A, Normal *Laxmi* seeds. B, Naked seeds.

The increased yields and better grade of blackarm (*Xanthomonas malvacearum*) resistance displayed by the progenies of selected plants, if they prove true to their character, would certainly strengthen the germplasm bank.

The authors are grateful to Mr. B. H. Katarki, Cotton Specialist, Dharwar, and

TABLE I  
Showing variations in economic characters in parent and mutant plants recorded in 1965-66

Sl. No.	Culture	Yield per plant average of 15 plants		G.P.	Mean halo length in mm.	Blackarm grade (under artificially infected field conditions)
		Kappas in gm.	Lint in gm.			
1	Mutant plant obtained from treating with Colchicine at 0.002% for 3 hours	8.0	2.3	28.4	20.1	3.5
2	Progeny of 1st selected plant	24.2	5.8	25.9	19.2	1.9
3	Progeny of 2nd selected plant	11.6	3.5	30.2	19.8	0.2
4	Control ( <i>Laxmi</i> )	20.2	7.0	34.5	24.8	5.4
5	do.	15.1	5.4	34.6	25.2	6.6

Dr. C. Kempanna, University of Agricultural Sciences, Bangalore, for their kind help and encouragement.

March 4, 1968.

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1. Franzke, C. J. and Ross, J. G., *Journal of Heredity*, 1952, **43**, 107.
2. Ross, J. G., Franzke, C. J. and Schuh, L. A., *Agronomy Journal*, 1954, **46**, 10.
3. Erichsen, A. W., Franzke, C. J., Sanders, M. E. and Ross, J. G., *Journal of Heredity*, 1962, **53**, 304.
4. Sanders, M. E. and Franzke, C. J., *Nature*, 1962, **196**, 696.
5. Atkinson, G. F., Franzke, C. J. and Ross, J. G., *Journal of Heredity*, 1957, **48**, 259.
6. Chen, C. H. and Ross, J. G., *Ibid.*, 1963, **54**, 96.
7. Dirks, V. A., Ross, J. G. and Harpstead, D. D., *Ibid.*, 1956, **47**, 229.

#### MALE STERILITY IN GUAR [CYAMOPSIS TETRAGONOLOBA (L.) TAUB.]

THE flower of guar [*Cyamopsis tetragonoloba* (L.) Taub.] is bisexual and typically papilionaceous containing the usual ten stamens, each having two anther lobes which burst to liberate pollen at a time when stigma is receptive and the flower is about to open, thus ensuring self-pollination.

In the guar collection grown for study in this Division during kharif of 1965, four abnormal plants were noticed. These were characterised by having relatively more profuse branching, smaller leaves and elongated peduncles producing a few 1- or 2-seeded pods. The flowers were small in size and so also the stamens. Acetocarmine smears of the pollen grains from these flowers indicated them to be completely sterile. Thus pollen sterility was present in the flowers. The few seeds that had formed were apparently due to natural cross-pollination.

F<sub>1</sub> progeny grown from these crossed seeds was all normal. In F<sub>2</sub> the total number of plants obtained was 245, out of which 193 (78.8%) were normal and 52 (21.2%) were sterile. The Chi-square value 1.82 indicated a good fit to the expected 3:1 ratio as it is less than 3.841 at 5% level. The data, therefore, indicated that pollen fertility is probably monogenic dominant to sterility condition. Male sterility can be designated as *ms* with its dominant allele as *Ms*.

This type of pollen sterility is nuclear as has been reported in crops such as tomato (Rick, 1956), Lima bean (Allard, 1953), etc., and has been exploited for hybrid seed production.

The material is under further study with regard to its test cross progeny. The line is being maintained through appropriate crossing of the male sterile individuals.

So far as we are aware, male sterility in guar has not been reported in literature.

Div. of Plant Introduction, S. P. MITAL.  
Indian Agric. Res. Inst., B. S. DABAS.  
New Delhi, T. A. THOMAS.  
February 23, 1968.

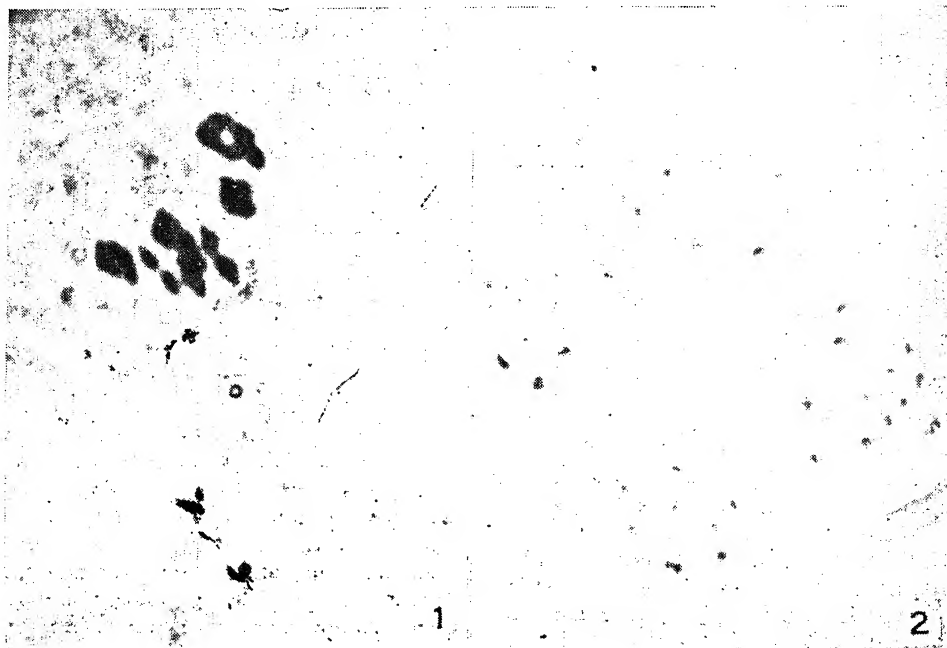
1. Allard, R. W., "A gene in lima beans pleiotropically affecting male sterility and seedling abnormality," *Proc. Am. Soc. Hort. Sci.*, 1953, **61**, 467.
2. Rick, C. M., "Cytogenetics of the tomato," *Advances in Genetics*, 1956, **8**, 267.

#### REVERSAL OF INDUCED AUTOTETRAPLOIDY TO DIPLOIDY IN BRASSICA CAMPESTRIS

THE process of evolution by duplication of chromosome numbers need not necessarily be unidirectional, the forms with low chromosome numbers being always primitive and those with higher numbers being always derived from them. A few cases of reversal from tetraploidy to diploidy are found in literature.<sup>1-3</sup> Such diploids arising from autotetraploids have been made use of in practical plant breeding in potatoes.<sup>4</sup>

One of the colchicine-induced autotetraploid plants of *Brassica campestris* ( $2n = 40$ ) which was used as a maternal parent in crosses with other tetraploids, gave rise to a diploid plant having 20 chromosomes. With regard to habit, vigour and other morphological characters, the plant looked, more or less, like the diploid from which the tetraploid was originally derived, except that it had slightly smaller flowers with anthers not so well developed. The plant was also self-incompatible as its progenitor and did not set any seed under bag. It, however, set a few seeds under cross-pollinated conditions. When mature anthers were squashed and stained in acetocarmine, the majority of pollen grains were seen to be shrunken and small and only about 25 to 30% of the grains were well filled and took good stain. The stainable pollen included a few giant grains probably unreduced gametes. The plant set only a few seeds indicating that

there was sterility equally on the female side also. Acetocarmine smears of pollen mother-cells showed mostly ten bivalents. A single quadrivalent was seen occasionally (Fig. 1). Unequal distribution of chromosomes was observed, but rarely, in second anaphase (Fig. 2).



FIGS. 1-2. Fig. 1. Metaphase I showing a ring quadrivalent and eight bivalents. Fig. 2. Unequal distribution of chromosomes in anaphase II.

In spite of the regular pairing of the chromosomes forming mostly ten bivalents, the plant was highly sterile indicating that sterility is probably the result of unfavourable genes coming together in the 'haploid' rather than due to chromosomal aberrations. Seed sterility in induced-autotetraploids is attributed to various causes including multivalent formation at meiosis and consequent unequal segregation of chromosome numbers at anaphase, formation of viable or inviable triploid seeds resulting from crossing with diploids and to genic causes. The high seed sterility in the diploid, arising as it does, from a tetraploid indicates that genic sterility is a major factor contributing towards the poor seed setting in induced autotetraploid *Brassica campestris*.

The 20-chromosome plant probably originated by parthenogenesis comparable to the origin of parthenogenetic haploids from diploids. The quadrivalent observed may be due to non-

disjunction as a quadrivalent in metaphase II was observed in one of the tetraploids derived from the plant which gave rise to the diploid. The occurrence of sterility, the presence of giant pollen grains, the presence of a quadrivalent and occasional unequal segre-

gation of chromosome numbers combined with the fact that these plants were raised in pots and the pollinations were done strictly under controlled conditions rules out the possibility of the plant being an accidental mixture.

Division of Genetics, D. SRINIVASACHAR.  
Indian Agric. Res. Inst.,  
New Delhi, January 30, 1968.

1. Belling, J. and Blakeslee, A. F., *Am. Nat.*, 1924, 58, 60.
2. Bolton, J. L. and Greenshields, J. E. R., *Science*, 1950, 112, 275.
3. Gairdner, A. E. and Darlington, C. D., *Genetica*, 1931, 13, 113.
4. Houghs, R. W. and Peloquin, S. J., *American Potato Journal*, 1958, 35, 701.
5. —, — and Ross, R. W., *J. Hered.*, 1958, 49, 103.
6. Nilsson, H., *Hereditas*, 1939, 25, 1.
7. Quadt, F., *Der Züchter*, 1955, 25, 241.
8. Randolph, L. F. and Fischer, H. E., *Proc. Nat. Acad. Sci.*, Wash., 1939, 25, 161.
9. Stanford, E. H. and Clement, W. M., *Agron. Journal*, 1958, 50, 589.

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## REVIEWS AND NOTICES OF BOOKS

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**Methods in Immunology and Immunochemistry** (Vol. I). Edited by Curtis A. Williams and Merrill W. Chasc. (Academic Press, New York and London), 1967. Pp. xxi + 479. Price \$22.00.

This multi-volume treatise covers the basic methods employed for research in immunology and immunochemistry. Practical procedures with operational details are presented, accompanied in each case by discussions of the problem and common pitfalls. The first volume covers natural and conjugated antigens, production of immune sera, animal handling, purification of immunoglobulins and antibodies. The first volumes fix the base and breadth of methodology. Subsequent volumes will be devoted to updating or enlarging certain areas in the context of current research trends. The work will serve as a handbook and guide to the methods employed in highly disciplined immunological research.

Chapter 1, Antigens, contains the following articles: Proteins: Factors in Preparing Some Common Antigens; Bacterial Antigens; Blood Group Antigens; Viruses; Conjugated and Synthetic Antigens; Lipids in Immunological Studies; Chapter 2, Production of Antiserum, contains the following articles: Immunogen Preparation; Immunization Procedures; Collection and Handling of Serum; Animal Handling; Chapter 3, Purification of Antibody, contains the following articles: Preparation of Immunoglobulin; Preparation of Specific Antibody; Chapter 4, Labelling of Antigens and Antibodies, contains the following articles: Radioisotopic Labelling; Ferritin-Labelled Antigens and Antibodies; Fluorescent Labels. Chapter 5, Studies of Immunoglobulin Structure, contains the following articles: Immunoglobulins: Conventions, Terminology, Models; Immunoglobulin Polypeptide Chains; Enzymatic Hydrolysis: Isolation of Fragments; Application of Structural Methodology.

C. V. R.

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**Underwater Acoustics** (Vol. 2). Edited by Vernon M. Albers. (Plenum Press, New York), 1967. Pp. xiii + 416. Price \$12.50.

This volume represents the Proceedings of an Institute sponsored by the Scientific Affairs

Committee of the North Atlantic Treaty Organization and conducted by the Pennsylvania State University at the Technical University of Denmark, Copenhagen, Denmark, from July 25 to August 5, 1966.

These papers, including extensive bibliographies, provide a valuable source of current knowledge in this area of study.

Among the subjects covered are advanced transducer developments, underwater sound in marine biology, flow-noise, sound propagation and ambient noise under ice, research on cavitation nuclei, sound scattering in the ocean, sound propagation in seas, underwater sound and marine geology, matched filter and correlation techniques, internal waves, and transmission rate limits in underwater acoustic telemetry.

C. V. R.

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**Geometry and Symmetry.** By Yale. (Holden-Day, Inc., 500, Sansome Street, San Francisco), 1968. Pp. xi + 288. Price \$10.75.

Designed as an introductory text for advanced undergraduates in mathematics or physics, this offers a systematic account of higher dimensional spaces with a demonstration of how group theory can be used seriously in geometry. The book concentrates on "practical geometry," placing emphasis on those topics and techniques of maximal use in all areas of mathematics.

The chapters contained in this book are:

1. Algebraic and Combinatoric Preliminaries;
2. Isometries Similarities: An Intuitive Approach;
3. An Introduction to Crystallography;
4. Fields and Vector Spaces: A Quick Review;
5. Affine Spaces and
6. Projective Spaces.

C. V. R.

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**Linear Transport Theory.** By Kenneth M. Case and Paul F. Zweifel. (Addison-Wesley Publishing Company), 1967. Pp. ix + 342. Price 140 sh.

The purpose of this book is to provide a unified modern treatment of linear transport problems, and in particular to exhibit the soluble cases. Its unique feature is the presentation of the problems primarily from a single point of view—that of singular eigen solutions. Taking this approach, the text

offers applications to neutron diffusion, plasma problems, radiative transfer, and sound propagation. Most of the advanced mathematics needed is developed in the text as simply as possible and in the form needed. Designed primarily as a graduate or advanced-graduate text for courses in neutron transport theory, the book will be found to be of use by practising nuclear engineers, astrophysicists, plasma physicists, and applied mathematicians.

C. V. R.

**New Linear Polymers.** By H. Lee, D. Stoffey and K. Neville. (McGraw-Hill Book Company, 330, West 42nd St., New York, N.Y. 10036), Pp. 374. Price \$17.50.

This is an introduction to the chemistry and technology of ten new commercial plastics which have become available only within the past few years. The polymers described are polyimides, polyamide-imides, polyester-imides, aromatic polyamides, polycyclamides, polybenzimidazoles, polyphenylene oxides, polysulfones, poly (*p*-xylylenes), and phenoxies. The history, chemistry, properties, applications and uses of these polymers are dealt with in detail.

This compact review literature on some of the newest polymers will be of value to polymer scientists and technologists. A. S. G.

**Isotopes in Research and Production—Translated from the German.** By H. Liebscher. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), Pp. 126.

This little popular publication in the series *Technical Fundamentals* deals with the fundamentals of radioactivity and the applications of radioactive nuclides in various fields of research—physics, chemistry, biology, agriculture, medicine, industry, etc. Emphasis is on the peaceful uses of atomic energy. The book is written in simple language and is amply illustrated. A. S. G.

**The Planetarium and Atmospherium.** By O. Richard Norton. (Naturegraph Publishers, 8339, West Dry Creek Road, Healdsburg, California, 95448), Pp. 176. Price: Cloth \$4.50, Paper \$2.75.

This is a readable booklet on the working of a planetarium. A special feature of the

book is the large number of illustrations—73, out of which 42 are photographs—to make clear the textual matter. The Zeiss planetarium and the Spitz planetarium and their workings are described in detail. A special chapter is devoted to the new device, the Atmospherium. If the planetarium projects the night sky, the purpose of its counterpart, the atmospherium, is to project the daytime sky and exhibit on the dome the changing daytime events such as cloud forms, etc. A. S. G.

**Russian-English Dictionary of Prestressed Concrete.** By Ben C. Gerwick, Jr. and V. P. Peters. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York, N.Y. 10011), 1966. Pp. 120. \$20.00.

Prestressed concrete as building material is having great impact in modern construction engineering. Rapid advances in this field have been made in Russia and America, and there is a large amount of Russian literature on the subject. The present dictionary is to help English-speaking and Russian-knowing architects and engineers to translate Russian literature on the subject of prestressed concrete and concrete construction. The dictionary lists about 13,000 terms. A. S. G.

#### Award of Research Degree

Utkal University has awarded the D.Sc. degree in the Faculty of Medicine to Dr. K. C. Sahu, S. C. B. Medical College, Cuttack, for his thesis entitled "Studies on Yaws and Adivasis in Orissa".

#### Books Received

**Solvent Properties of Surfactant Solutions.**

Edited by K. Shinoda. (Marcel Dekker, Inc., New York), 1967. Pp. ix + 365. Price \$18.50.

**Experimental Measurements Precision Error and Truth.** By N. C. Barford (Addison Wesley Publishing Co., Inc., West End House, 11, Hills, Place London, W. 1 England), 1967. Pp. xi + 143. Price 18 sh.

**Nuclear Reactor Materials.** By C. O. Smith. (Addison Wesley Publishing Co., Inc., East End House, 11, Hills Place, London, W. 1 England), 1967. Pp. viii + 262. Price \$13.50.

**The Planning of Milk Production in India.** By R. O. Whyte and M. L. Mathur. (Orient Longman's, Ltd., 36s Mount Road, Madras-2), 1968. Pp. viii + 221. Price Rs. 10.

# ISOLATION OF CUCURBITACIN C FROM *CUCUMIS PROPHETARUM* LINN.

M. GOPALA RAO AND L. RAMACHANDRA ROW

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ENSLIN *et al.*<sup>1</sup> recorded that cucurbitacins B and D were the main bitter principles of the fruit of *Cucumis prophetarum* Linn. of the South African variety. During our study of the bitter principles of Cucurbitaceæ, the fruits of *C. prophetarum*, collected from the hills around Waltair, were examined. The juice of these fruits was expressed and allowed to settle for some time when a gelatinous matter separated. It was filtered, extracted with alcohol and the extract concentrated, when a colourless crystalline compound was obtained. The pulp of the fruit also gave the same compound when extracted with alcohol. (Yield: 0.03% of the weight of the fresh fruits). Paper chromatography<sup>2</sup> using Whatmann No. 1 filter-paper, previously impregnated with alcoholic formamide and ethyl acetate-benzene (1:1) as solvent system showed one spot when sprayed with a 0.5% solution of potassium permanganate in a saturated aqueous solution of cupric acetate. The compound crystallised from ethanol as colourless needles, m.p. 205–07°,  $[\alpha]_D^{30} + 72.5^\circ$  (c, 0.9 ethanol);  $\lambda_{\max.}$  230 m $\mu$  ( $\epsilon$  13500);  $\nu_{\max.}^{\text{Nujol}}$ : 3675, 3575, 3485, 3370 (hydroxyl), 1728, 1250 (acetoxyl) and 1692, 1630 cm.<sup>-1</sup> ( $\alpha, \beta$ -unsaturated ketone). It exhibited the following colour tests: Liebermann-Burchard—pink colour changing to red, tetranitromethane—pale yellow, tetrazolium blue—negative and FeCl<sub>3</sub>—negative. It analysed for C<sub>32</sub>H<sub>48</sub>O<sub>8</sub>, 1 H<sub>2</sub>O. A point of significance is the tenacious retention of a molecule of water by the compound, which could not be removed even at 140°/0.2 mm. It formed an amorphous triacetate, C<sub>38</sub>H<sub>54</sub>O<sub>11</sub>, which still contained a free hydroxyl group ( $\nu_{\max.}^{\text{Nujol}}$ : 3455 cm.<sup>-1</sup>) and did not form the 2:4-dinitrophenylhydrazone.

Hydrogenation over Pd/CaCO<sub>3</sub> in ethanol furnished the dihydro derivative, colourless needles from methanol, m.p. 222–24°,  $[\alpha]_D^{30} + 90^\circ$  (c, 0.8 ethanol), which has no  $\alpha, \beta$ -unsaturated ketone ( $\lambda_{\max.}$  289 m $\mu$ ;  $\nu_{\max.}^{\text{CHCl}_3}$ : 1698 cm.<sup>-1</sup>), but still contains a double bond (tetranitromethane—pale yellow), that resisted hydrogenation. The bitter principle and its dihydro derivative consumed one mole of perbenzoic acid, each forming a monoepoxide. The

epoxide of the bitter principle, m.p. 180–82°, contains the  $\alpha, \beta$ -unsaturated ketone ( $\nu_{\max.}^{\text{Nujol}}$ : 1695, 1641 cm.<sup>-1</sup>). Thus the bitter principle contains two double bonds one of which is unaffected during hydrogenation, but reactive towards perbenzoic acid and the other is conjugated with a ketone; it can be reduced but is unreactive to perbenzoic acid.

Ozonolysis of the bitter principle furnished two aldehydes, 2-hydroxy isobutyraldehyde (II) and 2-methyl acrolein (III), isolated as their 2:4-dinitrophenyl hydrazones as in the case of cucurbitacins A, C and E.<sup>3-5</sup> This indicates that it has the same side chain as these cucurbitacins. Oxidation with periodic acid furnished a crystalline methyl ketone, C<sub>24</sub>H<sub>36</sub>O<sub>5</sub>, m.p. 230–32°,  $[\alpha]_D^{30} + 180^\circ$  (c, 0.98 ethanol) and a water-soluble acid, C<sub>6</sub>H<sub>10</sub>O<sub>3</sub>, which was obtained as a pale yellow gum that resisted crystallisation. The infra-red spectrum of this acid showed bands at 3500, 1715, 1665 and 980 cm.<sup>-1</sup> indicating the absence of acetoxyl group which might have hydrolysed during the reaction or subsequent working up. During similar oxidation of cucurbitacins D, E and I, *trans*-4-hydroxy, 4-methyl, pent-2-enoic acid (IV) was previously isolated as a crystalline solid, m.p. 102–103°. In spite of several attempts to purify this gum through chromatography over silica gel, only a pale yellow gum could be secured. Notwithstanding this difference, the acid from the bitter principle bears close resemblance to *trans*-4-hydroxy, 4-methyl, pent-2-enoic acid (IV) and consequently the bitter principle may be considered to possess the same side chain as cucurbitacins D, E and I with an acetoxyl function at C-25.

The methyl ketone (V), C<sub>24</sub>H<sub>36</sub>O<sub>5</sub> formed a triacetate, (pyridine-acetic anhydride), needles from ethanol, m.p. 158–60°,  $[\alpha]_D^{30} + 118^\circ$  and when treated with protonic agents like *p*-toluene sulphonic acid or methanolic hydrochloric acid underwent dehydration giving anhydrohexanor compound (VI, R=CH<sub>2</sub>OH), m.p. 179–80°, ( $\lambda_{\max.}$  242 m $\mu$ ;  $\nu_{\max.}^{\text{CHCl}_3}$  1660, 1590 cm.<sup>-1</sup>). When treated with 1N alcoholic alkali for 18 hr. at room temperature, both the bitter principle and its hexanor compound lost

formaldehyde which was identified by chromotropic acid colour test. The physical constants of the bitter principle and its reaction products agree well with those of cucurbitacin C (I) and its reaction products (Table I).

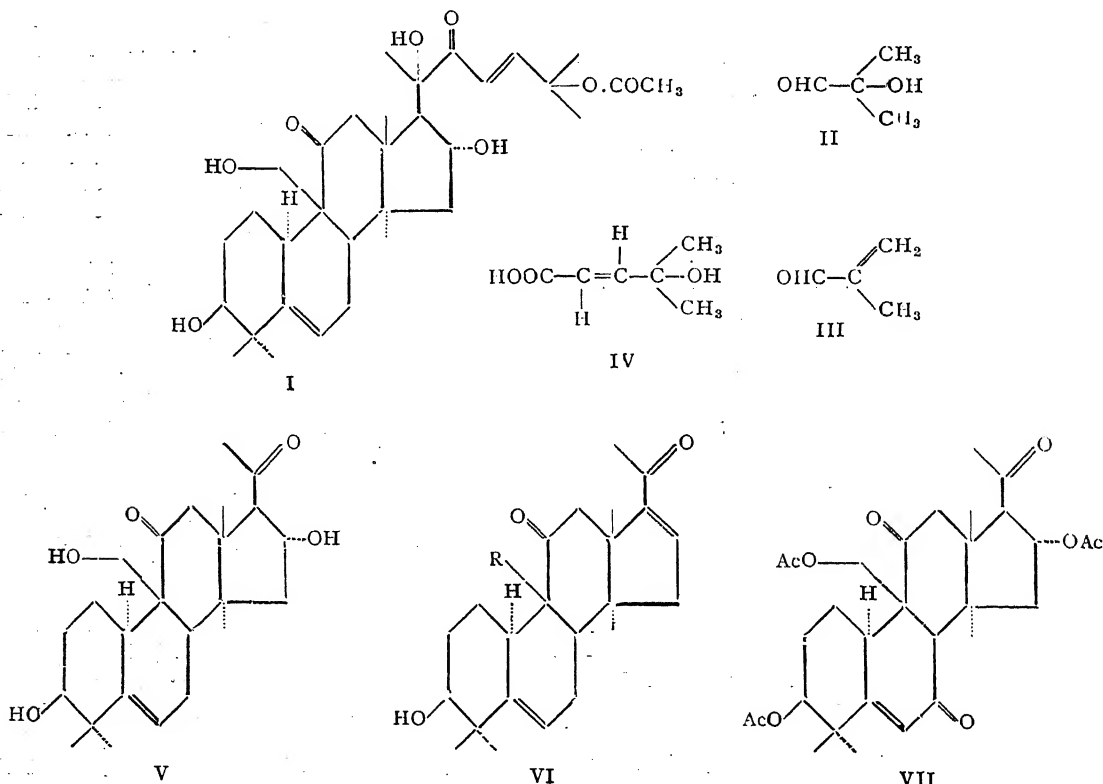
(c, 0.5 ethanol) and spectral data ( $\lambda_{\text{max}}$ , 242 m $\mu$ ;  $\nu_{\text{max}}^{\text{HCl}_3}$  1740, 1710 and 1668 cm.<sup>-1</sup>) agree well with those of cucurbitone C (VII). The anhydrohexanor compound (VI, R=CH<sub>2</sub>OH), when treated with alcoholic alkali under

TABLE I

Reaction	Product	Bitter principle	Cucurbitacin C
1.		m.p. 205-07° [ $\alpha$ ] <sub>D</sub> +72.5°	207-207.5° +95°
2. Catalytic reduction	.. Dihydro derivative	m.p. 222-24° [ $\alpha$ ] <sub>D</sub> +90°	226° +66°
3. HIO <sub>4</sub> oxidation	.. Hexanor compound -acetate	m.p. 230-32° [ $\alpha$ ] <sub>D</sub> +180° m.p. 158-60°	235-36° +185° 157-58°
4. Action of CH <sub>3</sub> OH-HCl on hexanor compound	Anhydrohexanor compound	m.p. 179-80°	178-79°

In order to confirm the identity, two more reactions were performed. The bitter principle triacetate on oxidation with chromium trioxide-acetic acid gave a crystalline product, whose physical constants, m.p. 232-35°, [ $\alpha$ ]<sub>D</sub> +160°

reflux decomposed to give formaldehyde (detected by chromotropic acid test and dimedone derivative) and  $\Delta^{16}$ -anhydroheptanor cucurbitacin C (VI, R=H), C<sub>23</sub>H<sub>32</sub>O<sub>3</sub>, m.p. 248-52°, [ $\alpha$ ]<sub>D</sub><sup>30</sup> -180° (c, 0.8 ethanol).





The N.M.R. spectra of the bitter principle and some of its reaction products were studied and they fully support the identification of the bitter principle as cucurbitacin C (I). Some of the important signals of the N.M.R. spectra are presented in Table II.

Pretoria, South Africa, for kindly comparing our samples with cucurbitacin C and hexanor cucurbitacin C, to Prof. A. J. Birch and Dr. G. S. R. Subba Rao, University of Manchester, for the N.M.R. spectra and to the University Grants Commission, for the award

TABLE II  
N.M.R. spectral data of the bitter principle and its reaction products

Solvent:  $\text{CDCl}_3$ , Internal standard: Tetramethylsilane

Compound	Chemical shift $\tau$ scale	Groups assigned
1. Bitter principle* (Cucurbitacin C) ..	3.1 s 4.30 m 7.98 s	Olefinic H at C-23 and C-24 Olefinic H at C-6 Acetate methyl
2. Dihydrocucurbitacin C* ..	4.36 m 7.98 s	Olefinic H at C-6 Acetate methyl
3. Hexanor cucurbitacin C triacetate ..	4.25 m 5.30 } 6.05 } AB q J = 11 cps 7.82 } 7.93 } s 7.96 } 8.00 }	Olefinic H at C-6 -CH <sub>2</sub> -OAc Methyl ketone and three acetate methyls
4. $\Delta^{16}$ -Anhydrohexanor cucurbitacin C diacetate	3.28 t, J = 2 c/s 4.25 m 5.35 } 5.99 } AB q J = 11 cps 7.92 } 8.17 } s 8.21 }	Olefinic H at C-16 Olefinic H at C-6 -CH <sub>2</sub> -OAc Methyl ketone and two acetate methyls
5. Cucurbitone C ..	3.78 d J = 2 cps 4.37 t, J = 7.5 cps 5.32 m 5.53 } 6.04 } AB q, J = 11.5 cps 7.86 } 7.95 } s 8.04 } 8.10 }	Olefinic H at C-6 -CH-O.CO.CH <sub>3</sub> C-16 -CH-O.CO.CH <sub>3</sub> C-3 -CH <sub>2</sub> -OAc Methyl ketone and three acetate methyls
6. $\Delta^{16}$ -Anhydroheptanor cucurbitacin C	3.18 t, J = 2.5 cps 4.42 m 7.68 s	Olefinic H at C-16 Olefinic H at C-6 Methyl ketone

\* Spectra taken in deuterated DMSO, s=singlet, d=doublet, t=triplet, q=quartet and m=multiplet.

Finally our identification was confirmed by direct comparison (m.m.p., I.R., and paper chromatography) of the bitter principle and its hexanor compound with authentic cucurbitacin C and hexanor cucurbitacin C, kindly made by Dr. P. R. Enslin. It may be mentioned that cucurbitacin C has so far been reported to occur in *Cucumis sativus* only.<sup>7</sup> The present isolation from *C. prophetarum* is the second instance of its occurrence.

#### ACKNOWLEDGEMENTS

We are highly indebted to Dr. P. R. Enslin, National Chemical Research Laboratory,

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1. Enslin, P. R., Rehm, S., Meeuse, A. D. II. and Wessels, J. H., *J. Sci. Food Agric.*, 1957, **8**, 679.
2. —, Joubert, T. G. and Rehm, S., *J. South Afric. Chem. Inst.*, 1954, **7**, 131.
3. —, Hugo J. M., Norton, K. B. and Rivette, D. E. A., *J. Chem. Soc.*, 1960, p. 4779.
4. —, —, — and —, *Ibid.*, 1960, p. 4787.
5. Lavie, D., Shvo, Y. and Willner, D., *J. Amer. Chem. Soc.*, 1959, **81**, 3062.
6. De-Kock, W. T., Enslin, P. R., Norton, K. B., Barton, D. H. R., Sklarz, B. and Bothner-By, A. A., *J. Chem. Soc.*, 1963, p. 3828.
7. Enslin, P. R., *J. Sci. Food Agric.*, 1954, **5**, 410.

## DEHYDRORETINOIC ACID FROM DEHYDRORETINAL

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INTEREST in retinoic acid has been renewed after Dowling and Wald<sup>1</sup> discovered that it has a high potency for growth but is ineffective in supporting the visual cycle. Further Thompson, Howell and Pitt<sup>2</sup> demonstrated that it is equally ineffective in reproduction. Ganguly<sup>3</sup> has reviewed this aspect recently.

Dehydroretinoic acid—the congener acid of the dehydroretinal series—may be of interest, although in a limited field, as dehydroretinal cycles are hitherto found to be preponderant in the freshwater fishes only.

Dehydroretinoic acid was first obtained by Farrar, Henbest and Jones<sup>4</sup> as an intermediate in the synthesis of dehydroretinal by bromination of synthetic methyl retinoate with N-bromosuccinimide and dehydrobromination of the resulting bromo compound. Recently, Isler and co-workers<sup>5</sup> have prepared several isomers of dehydroretinoic acid by direct synthesis.

While the aldehydes of retinol and dehydroretinal can be readily obtained by oxidation of the corresponding alcohols by manganese dioxide following the method of Ball, Goodwin and Morton<sup>6</sup> or its elegant modification by Wald,<sup>7</sup> earlier attempts to prepare the acids directly by Henbest, Jones and Owen,<sup>8</sup> were not successful. These authors could prepare retinoic acid by preparing the oxime of retinal, its dehydration to the nitrile by  $\text{POCl}_3$  in pyridine and subsequent hydrolysis. Even then the reaction was slow under mild conditions and under drastic conditions lead to extensive decomposition. Recently Barua and Barua<sup>9</sup> succeeded in the smooth oxidation of retinal to retinoic acid by use of Tollen's reagent (ammoniacal silver nitrate solution).

The less widely distributed dehydroretinol is more unstable than its congener retinol and it was thought worthwhile to see whether dehydroretinoic acid could be produced from the corresponding aldehyde dehydroretinal by use of the Tollen's reagent.

We report below a method for preparing dehydroretinoic acid starting from easily available freshwater fish liver oils.

Dehydroretinyl ester fraction (712 mg.,  $E_1^{1\%}$  at  $350\text{ m}\mu = 655$  in light petroleum)

obtained by chromatography of *B. bagarius* liver oil was taken in ethanol (60 ml.) and an aqueous solution of potassium hydroxide (3 ml., 50% solution) was added. The mixture was heated on a water-bath ( $65^\circ\text{C}.$ ) for 20 min. under nitrogen. It was then cooled to room temperature and after dilution with water (70 ml.) was extracted with peroxide-free ether (50 ml.). The extraction was repeated twice with 50 ml. portions of ether. The combined ether extract was dried with anhydrous sodium sulphate, the ether removed in vacuum and the residue dissolved in light petroleum and chromatographed on deactivated alumina (100 g., 10% water). Dehydroretinol was eluted with light petroleum containing 8–10% ether. After a second chromatography with light petroleum solvent, the yield of dehydroretinol was 340 mg.,  $E_1^{1\%}$  at  $350\text{ m}\mu = 1251$  in light petroleum.

A wad of cotton was introduced into the constriction of a glass chromatographic column (dia. 1.5 cm.) and manganese dioxide (8 g., B.D.H. precipitated) was packed into it. A solution of dehydroretinol, in light petroleum (10 ml.) was poured on the manganese dioxide column. Gentle pressure was applied to quicken the filtration. The filtrate was of a deep-orange colour characteristic of dehydroretinal. When the dehydroretinol solution had filtered down completely, the column was washed first with light petroleum (20 ml.) and then with a mixture of 2% ether in light petroleum (10 ml.). The combined filtrate was evaporated to dryness under reduced pressure and the residue dissolved in light petroleum and chromatographed on alumina (50 g., 8% water). Dehydroretinal which formed a bright orange-red zone on the column, was eluted with light petroleum containing 2% ether. It was chromatographed on deactivated alumina from light petroleum. Yield of dehydroretinal = 275 mg.,  $E_1^{1\%}$  at  $385\text{ m}\mu = 1392$  in light petroleum.

50 ml. each, of 10% aqueous solutions of silver nitrate and sodium hydroxide were mixed in a 500 ml. conical flask and dilute ammonia was added until the solution was clear. A solution of dehydroretinal (0.050 g.)

in ethanol (10 ml.) was added followed by pure ethanol (100 ml.). The reaction mixture was then left in the dark at 25°C. for 1.5 hr. with occasional shaking. At the end of this period the solution was filtered to remove the black precipitate of silver. The filtrate was washed with ether to remove non-acidic impurities. It was then cooled in ice and 5N hydrochloric acid was added until the solution was distinctly acid and precipitation of silver chloride complete. Crushed ice was added to the flask to check rise in temperature during neutralization. The solution was decanted into a separating funnel. The silver chloride residue was washed twice with distilled water and twice with dilute sodium hydroxide solution and all the washings were added to the funnel. After ensuring that the solution was acid it was extracted with light petroleum (50 ml.). The extraction was repeated with another 50 ml. of light petroleum. The combined extract was dried with anhydrous sodium sulphate, concentrated *in vacuo* and chromatographed on deactivated alumina (30 g., 8% water). On development with light petroleum, an orange band separated and flowed out of the column. This substance showed an ultra-violet absorption spectrum with flat maxima at 370 m $\mu$  and 330 m $\mu$  and was rejected. Dehydroretinoic acid remained strongly adsorbed on the column as a yellow zone. The column was washed with light petroleum containing 10% ether. It was then extruded and the dehydroretinoic acid zone was eluted with ethanol containing ammonia. The eluate was diluted with water and, after acidification with 5N hydrochloric acid, extracted with light petroleum (40 ml.). The extract was dried with anhydrous sodium sulphate and concentrated under reduced pressure.

The residue was dissolved in a small quantity of light petroleum (B.P. 40–60°) and kept for 1 hr. in an ice-bath when dehydroretinoic acid separated as plates. The recrystallized material has the following characteristics:

$E_{1\text{ cm.}}^{1\%}$  at 370 m $\mu$  = 1337; at 304 m $\mu$  (shoulder) = 426 (solvent—light petroleum, ethanol), M.P. 180° (uncorr.). The colour produced by SbCl<sub>3</sub> reagent (recorded in a Beckman DK-2 spectrophotometer) gave  $\lambda_{\text{max.}}$  at 643 m $\mu$ ,  $E_{1\text{ cm.}}^{1\%}$

643 m $\mu$  being 1213. On addition of a drop of 0.1(N) NaOH solution to the ethanolic solution of dehydroretinoic acid, the absorption maximum shifts to 360 m $\mu$  which could be brought back to 370 m $\mu$  on adding two drops of 0.1N HCl (personal communication from Prof. R. A. Morton). The i.r. spectrum (nujol mull) of the acid showed acid carbonyl band at 1695 cm<sup>-1</sup>. The methyl ester of the acid was prepared by refluxing the acid with methyl iodide in ethyl acetate and potassium carbonate for 3 hr. at 50°C. The esterified product, was chromatographed on 8% weakened alumina, when the methyl ester was obtained which could be crystallized from methanol at -20°, as pale yellow needle-shaped crystals M.P. 43–45° (uncorr.),  $\lambda_{\text{max.}}$  at 375 m $\mu$ , 307 m $\mu$  (inflection)  $E_{1\text{ cm.}}^{1\%}$  375 m $\mu$  = 1322. When this methyl ester is reduced with lithium aluminium hydride dehydroretinol is obtained,  $\lambda_{\text{max.}}$  351, 287 m $\mu$  inflection at 276 m $\mu$ ,  $E_{1\text{ cm.}}^{1\%}$  at 351 m $\mu$  being 1435 (solvent—ethanol). SbCl<sub>3</sub> colour  $\lambda_{\text{max.}}$  at 693 m $\mu$ ,  $E_{1\text{ cm.}}^{1\%}$  being 3917. When this dehydroretinol is 'cyclised' with dry 0.03N ethanolic HCl, the characteristic absorption bands of ethoxy anhydrovitamin A<sub>2</sub> at 350, 368 and 390 m $\mu$  were obtained. All these confirm the product as dehydroretinoic acid. The yield of dehydroretinoic acid from dehydroretinal is about 80% and is optimum when the reaction mixture in the oxidation experiment contained over 65% of ethanol.

1. Wald, G. and Dowling, J. E., *Proc. Nat. Acad. Sci.*, Wash., 1960, **46**, 587.
2. Thompson, J. N., Howell, J. Mc. C. and Pitt, C. A. J., *Biochem. J.*, 1961, **80**, 16.
3. Ganguly, J., *J. Sci. and Ind. Res.*, 1967, **26**, 1107.
4. Farrar, K. R., Hamlet, J. C., Henbest, H. B. and Jones, E. R. H., *Jour. Chem. Soc.*, 1952, p. 2657.
5. Isler *et al.*, *Helv. Chim. Acta*, 1962, **45**, 548.
6. Ball, S., Goodwin, T. W. and Morton, R. A., *Biochem. J.*, 1948, **42**, 516.
7. Wald, G., *J. Gen. Physiol.*, 1947, **31**, 489.
8. Henbest, H. B., Jones, E. R. H. and Owen, T. C., *J. Chem. Soc.*, 1952, p. 2657.
9. Barua, R. K. and Barua, A. B., *Biochem. J.*, 1962, **92**, 21 C.

# ENERGY COST AND MECHANICAL EFFICIENCY OF CLIMBING STAIRS WITH LOADS

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ALL of us climb stairs and carry loads some time or other. And carrying loads manually happens to be a common job by which innumerable 'coolies' earn their livelihood in India. At construction sites, warehouses, goods transport centres, factories, markets, residences, and other such places, a large number of workers are routinely employed for such work. In India, the worker generally carries the load on the head. Very often load carriage involves going up a staircase, be it a properly designed one as in a public building or an improvised one as found in building sites. Ergonomical studies on this type of muscular work have been undertaken by this laboratory for defining the optimum conditions of work. The present preliminary report on the experimental observations of the energy cost and efficiency of human volunteers using stairs to lift a load, forms a part of a comprehensive investigation in progress.

## EXPERIMENTAL RESULTS AND DISCUSSION

Seven healthy volunteers of average age 32 years and weight 53.04 kg. in light summer clothing, normally engaged in sedentary work, ascended stairs from the ground to the fourth floor of a building at the rate of one step per second, halting briefly for 8 to 10 seconds on each floor. The total period of work was 145 seconds ( $\pm 3$  secs.) on the average, and during this period the gas expired by the subject was collected in a Douglas Bag for determining the energy expenditure according to standard procedures (Consolazio *et al.*, 1963). These volunteers performed three experiments each;

first without any external load, when the weight carried is the subject's body weight, and then with loads of 15 and 30 kg. of stone chips in a basket on the head. The staircase had 96 steps arranged in a spiral fashion along three sides of a stairwell with a total vertical height of 18.54 metres. The mean air temperature and relative humidity during these experiments were 28.8°C. and 74.4% respectively. Everyday the experiment was performed 2 hr. after morning meal in order to minimise the specific dynamic action of food.

Table I presents the values of the energy expenditure in Kilocalories per minute for the seven subjects for three loadings. The mean energy cost for stairclimbing was 3.91, 5.22 and 6.13 Kcal./min. for external loads of 0, 15 and 30 kg. respectively, with a standard deviation of  $\pm 0.6$ . The energy cost for climbing with no external load obtained here is consistent with similar values for Indians (Banerjee, 1962; Ramanathan *et al.*, 1967), but comparable data for load carrying are not available. However, the energy costs of 4.8, 6.4 and 7.5 Kcal./min./65 kg. man for the three loadings are meaningful in comparison with data for grade walking outdoors and on treadmills (Durnin and Passmore, 1967).

The ratio of the energy cost to the gross weight carried (body weight plus external load) was found to be fairly constant within a range of 0.068 to 0.080. By a statistical test it was found that the ratio E/W was not different among subjects or with the load, and has a mean value of 0.074 Kcal./min./kg. gross weight. Therefore, the energy expenditure for

TABLE I

*Energy cost of seven human volunteers climbing stairs with and without a load on the head*

(E = Energy expenditure in Kcal./min., W = Gross weight in kg., M.E. = Mechanical efficiency in %)

Subject	Load kg.		0			15			30		
	Weight kg.		E	E/W	M.E.	E	E/W	M.E.	E	E/W	M.E.
RKH	48.5	3.79	0.078	22.6	4.71	0.074	23.4	6.05	0.077	23.4	
HM	51.8	4.03	0.078	22.5	5.14	0.074	21.7	6.56	0.081	28.6	
KR	41.0	2.85	0.069	26.7	4.47	0.080	20.0	4.99	0.070	25.2	
BM	65.6	4.82	0.073	25.4	6.15	0.076	25.3	6.92	0.072	24.2	
LNM	59.6	4.07	0.068	23.9	5.72	0.076	24.1	6.06	0.068	26.7	
AC	49.8	3.56	0.071	26.3	5.13	0.079	22.7	6.13	0.077	23.4	
SRD	55.0	4.27	0.078	22.4	5.20	0.074	24.3	6.20	0.073	23.9	
Mean	53.04	3.91	0.074	24.3	5.22	0.076	23.1	6.13	0.073	25.1	

similar work by a similar subject could be predicted to the first degree of approximation from

$$E \left( \frac{\text{Kcal}}{\text{min.}} \right) = 0.074 W \text{ kg.}$$

Mahadeva *et al.* (1953) obtained a relation between gross weight and energy cost for walking on a horizontal plane ( $E = 0.047 W + 1.02$ ) and for step test ( $E = 0.066 W$ ), with which the present equation bears comparison. The constant of multiplication in the present case is higher since stairclimbing is far more strenuous than walking.

The gross mechanical efficiency of physical work defined as,

$$100 \times \frac{\text{External work in kilogram meters} \times \text{Factor for conversion to Kcal.}}{\text{Internal energy expenditure in Kilocalories}}$$

$$= \frac{\text{Weight carried (kg)} \times \text{Vertical height (m.)} \times 0.234}{E (\text{Kcal./min.}) \times \text{Time of work (min.)}}$$

was computed in each case. The mechanical efficiency was found to have a mean value of 24.17% (range 20.0 to 28.6%). This gross mechanical efficiency of ascending stairs with loads upto 30 kg. may be taken as fairly constant. The efficiency values in the present study are quite compatible with such values reported for Occidentals for different muscular exercises (20–28%) (Bobbert, 1960) and for Indians climbing hills with a load 22.94% (Das and Saha, 1966).

Experimental studies on the same lines for establishing the relation between gross weight and energy cost and the constancy of mechanical efficiency under different conditions of

work stress, rate and mode of carrying are in progress.

#### ACKNOWLEDGEMENT

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1. Banerjee, S., "Studies in energy metabolism," *Indian Council of Medical Research, Special Report, Series No. 43*, ICMR, New Delhi, 1962.
2. Bobbert, A. C., "Energy expenditure in level and grade walking," *J. Appl. Physiol.*, 1960, **15**, 1015.

3. Conzelazio, C. F., Johnson, R. E. and Pecora, L. J., *Physiological Measurements of Metabolic Functions in Man*, McGraw-Hill Book Co., Inc., New York, 1963.
4. Das, S. K. and Saha, H., "Climbing efficiency with different modes of load carriage," *Ind. J. Med. Res.*, 1966, **54**, 866.
5. Lurnin, J. V. G. A. and Passmore, R., *Energy, Work and Leisure*, Heinemann Educational Books, Ltd., London, 1967, p. 40.
6. Mahadeva, K., Passmore, R. and Woolf, E., "Individual variations in metabolic cost of standardized exercises: Effects of food, age, sex and race," *J. Physiol.*, 1953, **35**, 801.
7. Ramanathan, N. L., Datta, S. R., Roy, B. N., Chatterjee, A. and Mallick, L. N., "Energy cost of different muscular tests performed by Indian subjects," *Indian J. Occupational Health*, 1967, **10** (12), 253.

### HARMONIA ARCUATA FABRICIUS (COCCINELLIDAE)—PREDATORY ON THE RICE PLANT HOPPERS SOGATELLA FURCIFERA HORVATH AND NILAPARVATA LUGENS STÅL

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TWO species of delphacid plant hoppers, viz., *Sogatella furcifera* Horvath, the white back plant hopper and *Nilaparvata lugens* Stål, the brown plant hopper have assumed major pest status in paddy with the intensive cultivation of high yielding rice varieties under high fertility levels. In addition to direct damage by sucking the sap and injecting toxins into the rice plant, their role as vectors

of rice virus diseases has also been recognised recently in many parts of the world.

In the course of routine field observations on the parasites and predators of rice pests at the Central Rice Research Institute, Cuttack, during 1966 and 1967, the authors observed a coccinellid beetle as a predator on the two rice delphacids, viz., *S. furcifera* and *N. lugens*. This has been identified as *Harmonia arcuata*

Fabricius and is the first record of its predacious habit on the two rice delphacids. "Normally this beetle has a number of black spots on its pronotum as well as the elytra. The elytral black spots tend to become confluent on the shoulder, in the middle and in the apical regions. In many cases, however, there is a reduction of spots both on the pronotum and the elytra. In the specimens (sent for identification) the reduction has gone to an extreme" (Kapur, 1967).

There was a severe incidence of white back plant hopper and the brown plant hopper in the standing *Kharif* (July-December) rice crops, particularly in the high yielding varieties

hopper population thus became gradually less by end of October after which the population of beetles also dwindled considerably. In view of its voracious feeding habit, it may prove to be an effective predator in the biological control of the rice plant hoppers.

Laboratory observations confirmed that the grubs as well as adults of this beetle readily fed on the nymphs as well as adults of *S. furcifera* and *N. lugens*, leaving behind portions of legs and wings. The eggs of *H. arcuata* were laid in clusters on rice leaves. The grub and pupal stages (Fig. 1) lasted for 16 to 20 and 4 to 5 days respectively and the adults lived for 10 to 12 days in the laboratory.

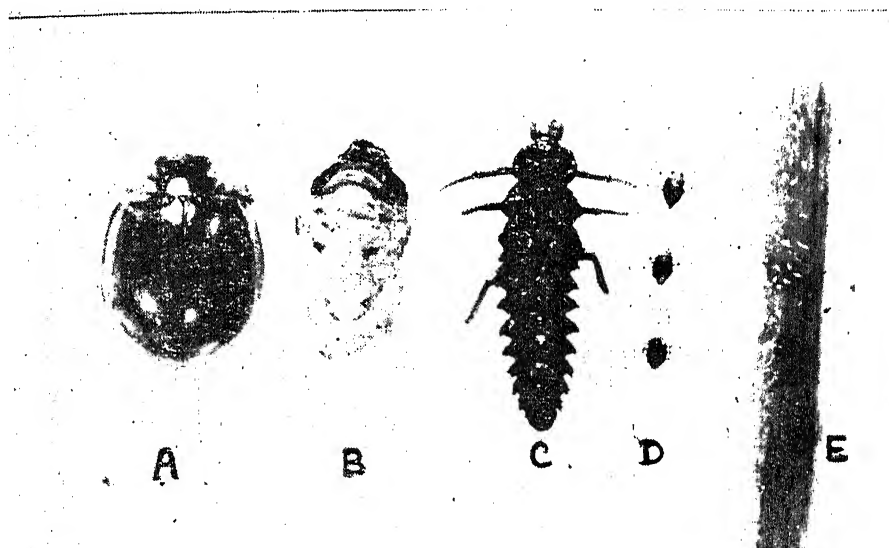


FIG. 1. *Harmonia arcuata* Fabr. (A) Adult; (B) Empty pupal skin; (C) Full-grown grub; (D) Newly hatched grubs; (E) Eggs on rice leaf.

during August and September in 1966 and 1967. Preliminary field observations during these two years indicated that the build-up of the plant hopper population in the rice fields was closely followed by a very rapid multiplication of this predacious beetle during mid-August to end of September. Besides, rice crops heavily infested with the above two hopper species invariably contained very large numbers of the beetle at all stages of development. The grubs and adults of this beetle appeared to check very effectively the hoppers' biotic potential by its predacious habit. The

Detailed studies on its life-history and its population dynamics in relation to rice plant hoppers are in progress.

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1. Kapur, A. P., Identification of *Harmonia arcuata* Fabr., Personal communication

## LETTERS TO THE EDITOR

### ON THE EKMAN LAYER IN A ROTATING HYDROMAGNETIC FLUID

CONSIDER a situation, in which a large body of weakly conducting viscous incompressible, rotating fluid, initially at rest under gravity, is set into motion by the action of a steady uniform tangential stress applied at the horizontal free surface  $z=0$ . Let  $H_0$  be a uniform magnetic field imposed along Z-axis and  $\Omega$  be the constant angular velocity about the same axis in a rotating frame of reference OXYZ. Assuming that the induced magnetic field due to the flow may be neglected with respect to the applied magnetic field, it can

be shown<sup>1</sup> that the velocity vector  $\vec{v} = [u(z, t), v(z, t), 0]$  satisfies the equations of motion

$$\begin{aligned} \frac{\partial u}{\partial t} - 2\Omega v &= \frac{\partial^2 u}{\partial z^2} - mu, \\ \frac{\partial v}{\partial t} + 2\Omega u &= \frac{\partial^2 v}{\partial z^2} - mv, \end{aligned} \quad (1)$$

where

$$m = \frac{(\sigma \mu^2 H_0^2)}{\rho} \quad (2)$$

The initial and boundary conditions are:

$$t=0, \quad u=v=0 \quad \text{for } z \leq 0,$$

$$t>0, \quad \frac{\partial u}{\partial z} = S, \quad \frac{\partial v}{\partial z} = 0 \quad \text{at } z=0,$$

$$u \rightarrow 0, \quad v \rightarrow 0 \quad \text{as } z \rightarrow -\infty. \quad (3)$$

We solve this system of equations by the Laplace transform technique and obtain

$$\begin{aligned} u + iv &= \frac{S \sqrt{\nu}}{2 \sqrt{m + 2i\Omega}} \left[ e^{\sqrt{(m+2i\Omega)(\nu)} z} \right. \\ &\quad \times \operatorname{erfc} \left\{ -\frac{z}{2 \sqrt{\nu t}} - \sqrt{(m+2i\Omega)} t \right\} \\ &\quad - e^{-\sqrt{(m+2i\Omega)(\nu)} z} \operatorname{erfc} \left\{ -\frac{z}{2 \sqrt{\nu t}} \right. \\ &\quad \left. \left. + \sqrt{(m+2i\Omega)} t \right\} \right]. \end{aligned} \quad (4)$$

For small  $t$ , this expression leads to

$$\begin{aligned} u &= S \left( 1 + \frac{mz^2}{6\nu} \right) \left[ 2 \left( \frac{\nu t}{\pi} \right)^{\frac{1}{2}} e^{-(z^2/4\nu t)} \right. \\ &\quad \left. + z \left( 1 + \operatorname{erf} \frac{z}{2 \sqrt{\nu t}} \right) \right] \\ v &= \frac{1}{3} S \Omega \left[ 2 e^{-(z^2/4\nu t)} \left( \frac{\nu t}{\pi} \right)^{\frac{1}{2}} \frac{z^2}{\nu} \right. \\ &\quad \left. - \frac{z^3}{\nu} \left( 1 + \operatorname{erf} \frac{z}{2 \sqrt{\nu t}} \right) \right], \end{aligned} \quad (5)$$

while for large  $t$ ,

$$\begin{aligned} u &= \frac{S e^{\alpha z} \cos(\beta z - \theta)}{r} \\ &\quad - \left( \frac{\nu}{t\pi} \right)^{\frac{1}{2}} \frac{S}{m^2 + 4\Omega^2} \exp. \left( -\frac{z^2}{4\nu t} - mt \right) \\ &\quad \times \{ m \cos 2\Omega t - 2\Omega \sin 2\Omega t \}, \\ v &= \frac{S e^{\alpha z} \sin(\beta z - \theta)}{r} \\ &\quad + \left( \frac{\nu}{t\pi} \right)^{\frac{1}{2}} \frac{S}{m^2 + 4\Omega^2} \exp. \left( -\frac{z^2}{4\nu t} - mt \right) \\ &\quad \times \{ 2\Omega \cos 2\Omega t + m \sin 2\Omega t \}, \end{aligned} \quad (6)$$

where

$$\begin{aligned} \alpha, \beta &= \sqrt{\frac{\Omega}{\nu}} (\sqrt{\lambda^2 + 1} \pm \lambda)^{\frac{1}{2}}, \quad \lambda = \frac{m}{2\Omega}, \\ \tan \theta &= \frac{\beta}{\alpha}, \quad r = (\alpha^2 + \beta^2)^{\frac{1}{2}}. \end{aligned} \quad (7)$$

For small  $t$ , the velocity changes appreciably over distances of order  $(\nu t)^{\frac{1}{2}}$  and for large  $t$ , the first part of (7) represents the Ekman layers which are confined to a surface stratum whose depth is of order  $1/\alpha$  from the free surface while the last terms represent the inertial oscillations very small in magnitude but persistent.

For  $t \rightarrow \infty$  (in the steady case),<sup>2</sup> the fluid velocity has its maximum magnitude  $S/r$  and has a direction  $\theta$  in a clockwise sense from the applied stress. With increase in the depth below the free surface, the direction of the velocity rotates uniformly in a clockwise sense and the magnitude falls off exponentially at what might be called the penetration depth equal to  $\pi/\alpha$ , the direction is opposite to that at the surface. Figure 1 shows the projection of the velocity vector at a number of depths  $8\sqrt{\Omega z/\nu} = 0, -1, -2, \dots$  (for  $\lambda=0$  and 1, on to a horizontal plane, the curve traced out by the end-points of the vector being a logarithmic spiral in each case. These are found to diminish in size with the increase in  $\lambda$ , i.e., in the strength of the magnetic field.

The net flux of fluid volume in the surface layer across vertical planes is given by

$$Q_x = \frac{S\nu\lambda}{2\Omega(\lambda^2 + 1)}, \quad Q_y = -\frac{S\nu}{2\Omega(\lambda^2 + 1)} \quad (8)$$

showing that the effect of the magnetic field is to contribute a flux (which vanishes

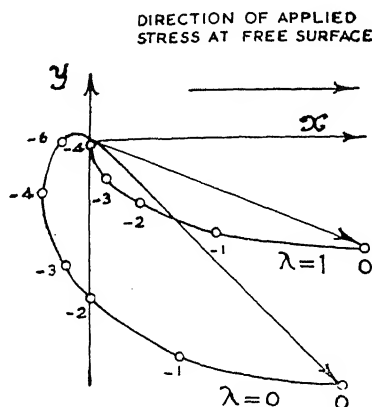


FIG. 1. The velocity vector in a rotating conducting fluid for  $\lambda=0$  and 1.

otherwise) in the direction of the applied stress.

Dept. of Applied Maths., V. VIDYANIDHI.  
Andhra University, Waltair, April 18, 1968.

1. Pai, S. I., *Magnetogasdynamics and Plasmadynamics*, Springer-Verlag, 1962, p. 65.
2. Lamb, H., *Hydrodynamics*, Cambridge University Press, 1952, p. 593.

### UREY-BRADLEY FORCE FIELD OF SOME $XY_6$ SYSTEMS

VIBRATIONAL spectra of octahedral  $XY_6$  type molecules and radicals have been subjected to theoretical analysis by a few authors<sup>1-6</sup> using different types of force fields. Recently, the infrared spectra of several hexachloro complexes have been measured and the nature of the co-ordination bonds has been discussed on the basis of force constants evaluated by Hiraishi *et al.*<sup>7</sup> The difficulties met with in solving the secular equations due to the presence of identical force constant element ( $H + 0.55F$ ) under the three different species which results by employing the general form of Urey-Bradley potential function have been overcome to some extent by them by introducing two more interaction constants  $k$  and  $h$  in the potential energy function. In addition to the above constants representing the interaction between two bonds in the same diagonal ( $k$ ) and the interaction between two angles in two perpendicular planes ( $h$ ), we have introduced the additional interaction between two angles in the same plane also ( $g$ ) in the ordinary form of Urey-Bradley force field. With the above inclusions, the modified

Urey-Bradley force field elements obtained are as follows:

$$\begin{aligned} a_{1g} \text{ species: } F_{11} &= K + 4F + k \\ e_g \text{ species: } F_{22} &= K + 0.7F + k \\ f_{1u} \text{ species: } F_{33} &= K + 1.8F - k \\ F_{44} &= r^2(H + 0.55F + 2h) \\ F_{34} &= 0.9rF \\ f_{2g} \text{ species: } F_{55} &= r^2(H + 0.55F - 2g) \\ f_{2u} \text{ species: } F_{66} &= r^2(H + 0.55F - 2h) \end{aligned}$$

With these constants included in the simple Urey-Bradley force field, a unique solution of the secular equations is possible which therefore gives the best fit between the observed and calculated frequencies. The modified Urey-Bradley force field is applied for  $PtCl_6$  and  $PdCl_6$  ions also where infrared active fundamentals are available. With angle interaction constant  $g$  omitted in the  $f_{2g}$  species, other major force constants are calculated and the  $\nu_6$  frequencies under the  $f_{2u}$  species, which have not been recorded so far for these complexes are calculated. The frequencies calculated for  $PtCl_6$  and  $PdCl_6$  ions are  $68 \text{ cm}^{-1}$  and  $126 \text{ cm}^{-1}$  respectively. The potential constants evaluated using the modified Urey-Bradley force field for the hexafluoride molecules and hexachloride ions are given in Tables I and II respectively.

TABLE I  
Potential constants of octahedral hexafluorides  
(md/Å)

Molecule	K	k	II	h	g	F
$SF_6$	3.973	0.205	0.491	0.052	0.037	0.627
$SeF_6$	4.433	0.277	0.395	0.069	0.029	0.217
$TeF_6$	4.808	0.163	0.244	0.048	0.020	0.125
$WF_6$	4.358	0.303	0.956	-0.012	0.005	0.480
$ReF_6$	3.565	-0.120	-0.048	-0.003	-0.044	0.724
$OsF_6$	4.140	-0.022	0.057	0.005	-0.096	0.465
$IrF_6$	4.446	-0.011	0.219	-0.014	-0.060	0.239
$PtF_6$	3.932	-0.330	0.156	0.017	0.059	0.223
$UF_6$	2.930	-0.063	0.078	-0.083	-0.088	0.551
$NpF_6$	2.827	-0.058	0.064	-0.055	-0.113	0.476
$PuF_6$	2.910	-0.153	0.078	-0.043	-0.118	0.398

TABLE II  
Potential constants of platinum and palladium  
hexachloride ions (md/Å)

Radical	K	k	II	h	F
$PtCl_6$	1.861	0.206	0.081	0.044	0.102
$PdCl_6$	1.493	0.221	0.088	-0.013	0.096

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Physics Department, K. VENKATESWARLU,  
Kerala University, Miss V. MALATHY DEVI,  
Alwaye-4, March 12, 1968.

1. Heath, D. E. and Linnet, J. W., *Trans. Farad. Soc.*, 1949, **45**, 264.
2. Venkateswarlu, K. and Sundaram, S., *Z. Physik Chem.*, 1956, **9**, 174.
3. Pistorius, C. W. F. T., *J. Chem. Phys.*, 1958, **29**, 1328.
4. Claassen, H. H., *Ibid.*, 1959, **30**, 968.
5. Block, H., *Trans. Farad. Soc.*, 1959, **55**, 867.
6. Venkateswarlu, K. and Malathy Devi, V., *Proc. of the Symposium on Raman and Infrared Spectroscopy*, Ernakulam, 1964.
7. Hiraishi, J., Nakagawa, I. and Shimanouchi, T., *Spectrochimica Acta*, 1964, **20**, 819.

### ZEEMAN QUADRUPOLE SPECTRUM OF 2, 4-DICHLOROANILINE

RESULTS of the analysis of the Zeeman quadrupole spectrum of  $^{35}\text{Cl}$  in single crystals of 2,4-dichloroaniline are reported in this note. The pure quadrupole spectrum consists of two lines of frequencies 34.854 and 34.734 Mc/s. at 77° K.<sup>1</sup> and 34.33 and 34.20 Mc/s. at room temperature.<sup>2</sup> Chlorine which is ortho to the amino group Cl (1) has higher frequency and the chlorine Cl (2) which is para to the amino group has the lower frequency.<sup>1</sup> X-ray crystallographic data for this compound are not available in literature. But Groth<sup>3</sup> has given the morphological data. The crystal is reported to be of the orthorhombic class with  $a : b : c = 1.4487 : 1 : ?$ . The present studies of Zeeman effect are carried out at room temperature, adopting the experimental technique that is already described.<sup>4</sup>

Each of the NQR lines gives two zero splitting loci. The analysis is carried out by plotting these loci setting the growth axis of the cylindrical crystal parallel to the r.f. axis and by refining the loci using the method of least squares. The analysis has led to the following results.

(1) There are two inequivalent  $z$ -directions for each of the two C-Cl bonds in the crystal as evident from Table I.

TABLE I

	Mc./s.	Locus I	Locus II
Orthochlorine ..	34.33	$\theta = 91^\circ 56'$ $\phi = 68^\circ 9'$	$\theta = 88^\circ 25'$ $\phi = 143^\circ 22'$
Parachlorine ..	34.20	$\theta = 90^\circ 30'$ $\phi = 21^\circ 58'$	$\theta = 90^\circ 30'$ $\phi = 308^\circ$

This sets the limit for the minimum number of molecules in the unit cell as two.

(2) The angular separations of these two directions are found to be nearly the same for both the chlorines and equal to about  $74^\circ 22'$ .

(3) C-Cl para and C-Cl ortho bond angle is calculated to be  $120^\circ 48' \pm 52'$  which agrees within the experimental error with the expected angle of  $120^\circ$ .

(4) The growth axis of the cylindrical crystal is identified to be the 'c'-axis, the cleavage planes being parallel to this axis. The present observations have shown that the two  $z$ -axes of the field gradients lie in the 'ab' plane as these are found to be approximately  $90^\circ$  from the c-axis. This conclusion is in keeping with the calculations of Shimomura<sup>5</sup> which indicate that if an orthorhombic crystal has two inequivalent field gradient  $z$ -axes, then both the  $z$ 's should lie in the 'ab' plane, 'bc' plane or 'ac' plane. For this crystal the two  $z$ 's lie in the 'ab' plane.

(5) Both the field gradients have the same asymmetry parameter. The measured values of this parameter, shown below, have led to the evaluation of the bond characters.

	Frequency Mc/s.	$\eta$	Double bond charac- ter	Single bond charac- ter	Ionic charac- ter
Cl (1)	34.33	$0.07 \pm 0.02$	2.24	75.78	21.98
Cl (2)	34.20	$0.06 \pm 0.02$	1.89	75.58	22.53

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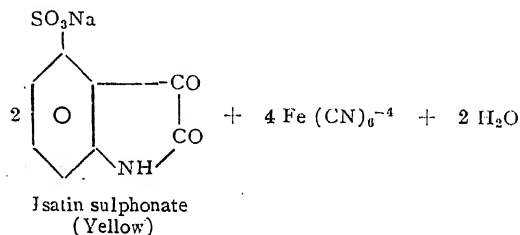
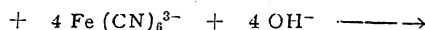
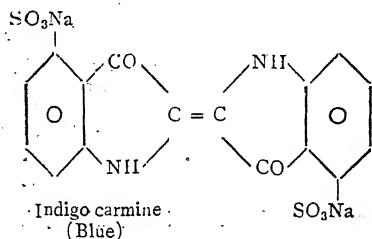
Magnetic Resonance Labs., B. KANTIMATI,  
Physics Department,  
Andhra University,  
Waltair, April 27, 1968.

1. Bray, P. J. and Barnes, R. G., *J. Chem. Phys.*, 1957, **27**, 551.
2. Nagarajan, V., *Curr. Sci.*, 1962, **31**, 279.
3. Groth, P., *Chemische Krystallographie*, p. 177.
4. Kantimati, B., *Curr. Sci.*, 1967, **36**, 40.
5. Shimomura, K., *J. Phys. Soc., Japan*, 1957, **12**, 652.

### ESTIMATION OF INDIGO CARMINE WITH POTASSIUM FERRICYANIDE

THE determination of indigo and indigo carmine is of considerable interest in view of their commercial importance. A review of literature shows that several oxidimetric reagents<sup>1-6</sup> have been proposed for the estimation of indigo carmine. Potassium permanganate<sup>1</sup> and cerium (IV) sulphate<sup>3</sup> do not oxidise indigo carmine quantitatively. Sodium vanadate,<sup>2</sup> potassium dichromate,<sup>4</sup> potassium iodate,<sup>5</sup> chloramine-T<sup>6</sup> and iodine<sup>6</sup> oxidise indigo carmine quantitatively under a prescribed set of conditions. The present communication reports our investigations on the oxidimetric estimation of indigo carmine with potassium ferricyanide in alkaline medium.

About 0.6 g. of indigo carmine (E. Merck) was accurately weighed and dissolved in 500 ml. of double distilled water. Approximately decinormal potassium ferricyanide solution (E. Merck, Analar, recrystallised salt) prepared in double distilled water was standardized by the iodimetric method.<sup>7</sup> Analar reagent grade chemicals were employed in the preparation of other solutions. The following procedure was found to be satisfactory after careful investigation of a large number of titrations of indigo carmine with potassium ferricyanide.



sium ferricyanide was obtained in a blank titration.

Detailed investigation of the indigo carmine system has shown that:

- (1) Quantitative results are obtained if indigo carmine is made to react with a large excess of potassium ferricyanide in sodium hydroxide media ranging from 0.3 to 2.0 N for 7-60 minutes.
- (2) Indigo carmine undergoes four-electron oxidation to light yellow isatin sulphonate.
- (3) 1-30 mg. of indigo carmine can be accurately estimated under the conditions described in the procedure.
- (4) Foreign ions such as  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Cl}^-$ ,  $\text{NO}_3^-$ , and  $\text{SO}_4^{2-}$  have no influence on the oxidation of indigo carmine.
- (5) Direct titration of indigo carmine with visual or potentiometric end-points gives erratic results.
- (6) Oxidation of indigo carmine is not quantitative in acid medium.

The results show that the oxidation of indigo carmine can be stoichiometrically represented as follows:

An aliquot of indigo carmine solution, 25 ml. potassium ferricyanide and 6 ml. of 5 N lithium hydroxide were taken and diluted to ml. in a 250 ml. iodine flask. After 10 minutes, 20 ml. of 4 N hydrochloric acid, 10 ml. of 10% potassium iodide and 10 ml. of 30% zinc sulphate solution were added and the liberated iodine was titrated with 0.1 N sodium thiosulphate using starch indicator. The iodimetric titre corresponding to 25 ml. of potas-

It may be concluded that potassium ferricyanide is capable of rupturing the  $\text{C}=\text{C}$  bonds in indigo carmine and can be used as a titrimetric reagent for estimating the organic compound in alkaline solution.

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Research in Chemistry, H. SANKE GOWDA.  
Manasa Gangothri, D. S. MAHADEVAPPA.  
Mysore-6, India, February 10, 1968.

1. Bloxam, W. P., *J. Soc. Chem. Ind.*, 1906, 25, 735.
2. Gopala Rao, G. and Narasimha Sastry, N., *Curr. Sci.*, 1952, 21, 189.
3. — Venkateswara Rao, N. and Subramanyam, I., *Z. Anal. Chem.*, 1956, 151, 353.
4. — and Venkateswara Rao, N., *Ibid.*, 1956, 151, 347.
5. — and —, *Acta Chim. Acad. Sci.*, Hungary, 1961, 26, 489.
6. Marigangiah and Mahadevappa, D. S., *J. Mysore Univ.*, Section B, 1965, 19, 3.
7. Kolthoff, I. M. and Belcher, R., *Volumetric Analysis*, Interscience Publishers, New York, 1957, 3, 236 & 344.

### CHEMICAL COMPONENTS OF THE FOLLICLES OF *LEPTADENIA* *RETICULATA*

*Leptadenia reticulata*, Wight and Arn.<sup>1</sup> is one of a number of medicinal plants belonging to the family Asclepiadaceæ that have been recorded to be useful in the Indian indigenous system of medicine.<sup>2,3</sup> Murti and Seshadri<sup>4</sup> examined the roots and stems of the plant in detail and isolated significant amounts of stigmasterol along with some  $\gamma$ -sitosterol. Agarwal *et al.*<sup>5</sup> found that the aqueous extract of *L. reticulata* had a prolonged and pronounced hypotensive effect in anæsthetised dogs. The follicles of the plant are eaten as vegetable in times of scarcity. Since there is no record of any work on the chemical components of the follicles, which have been observed by us to yield yellow latex, we have examined systematically the chemical components of the pericarp and the seeds; the results are reported in brief.

**Pericarp.**—Fresh pericarp of the follicles were cut into thin slices and extracted with acetone three times by cold maceration each time lasting for 8 hr. The total extracts were concentrated *in vacuo* to remove all the organic solvent with a little addition of water towards the last stages of concentration. The aqueous concentrate was shaken with petroleum ether, ether and ethyl acetate in succession. The ether and ethyl acetate extracts gave strong colour reactions for flavonoids. When paper-chromatographed, the ether extract was found to contain a single flavonol and the ethyl acetate extract showed three spots, on exposure to ammonia, indicating the presence of three flavonoid glycosides. On further examination, the flavonol was identified to be quercetin by its m.p., direct comparison with an authentic sample of the compound through paper

chromatography in five solvent systems and preparing its acetate identical with quercetin penta-acetate.

The flavonoid glycosides in the ethyl acetate extracts were separated by preparative paper chromatography on Whatman filter-papers No. 3 (*n*-butanol: 27% acetic acid = 1 : 1) and the methanol eluates from the three zones studied by paper chromatography in five solvent systems and colour reactions. The glycosides from the three eluates were identified as iso-quercitrin, rutin and hyperoside by direct comparison with authentic samples of the compounds and getting the same aglucone, quercetin and the sugars, glucose, glucose and rhamnose, and galactose respectively.

**Seeds.**—Fresh seeds in the follicles were minced in a Waring blender with some water and then extracted three times with hot acetone under reflux. The aqueous concentrate after removal of acetone was shaken with ethyl acetate till no more yellow colour could be extracted. The residue from ethyl acetate was worked up for the flavonoid glycoside (single), which was isolated and identified as hyperoside. The aqueous layer was concentrated further to a syrupy consistency on a steam-bath and poured into a large volume of acetone, when significant amounts of a crystalline solid separated. This was filtered off and recrystallised twice from hot aqueous alcohol, when colourless prisms,  $C_6H_{12}O_6$ , m.p. 225–26° were obtained; yield, about 5% on the dry basis. The substance was sweet to taste and non-reducing. It was easily soluble in water, but insoluble in ether and chloroform. An aqueous solution of the compound did not show any optical activity. On acetylation with acetic anhydride and anhydrous sodium acetate, it yielded a hexa-acetate, m.p. 212–13°. On esterification with propionic acid and concentrated sulphuric acid, it yielded a hexa-propionate, m.p. 99–100°. The compound was identified as *meso*-inositol<sup>6,7</sup> (*myo*-inositol,  $\beta$ -inositol) and the identity was confirmed by direct comparison with an authentic sample by mixed m.p. determination and paper chromatography. The acetone filtrate on concentration to a very small volume yielded colourless needles, m.p. 194–96°, which gave an acetate, m.p. 195–96°. This indicated that the substance could be *meso*-inositol mono-methyl ether.<sup>6</sup>

**Latex.**—The yellow latex that could be obtained while plucking the follicle or making

longitudinal incisions with a blade coagulated in a few minutes. The yellow pigments of the latex were easily extracted with cold acetone from the coagulum and the same flavonol glycosides as in the pericarp were identified. From the chloroformic extract of the coagulum  $\gamma$ -sitosterol, m.p. 140–41° (acetate, m.p. 132°) was isolated, but no stigmasterol could be identified.

It is interesting to note that the seeds of *L. reticulata* biosynthesise a high proportion of meso-inositol (Bios I) when compared to many other plants and appear to be one of the exceptionally rich sources for meso-inositol, the others being citrus fruits<sup>8</sup> and the berries of *Viscum album*<sup>9</sup> (about 1.2% on the fresh basis).

The flavonol glycosides of *L. reticulata* are recorded for the first time, and the occurrence of quercetin (and its glycosides) without any flavone agrees with earlier observations on the distribution of flavonoids in Asclepiadaceæ.<sup>10</sup>

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of Postgraduate,  
Medical Education and  
Research,  
Pondicherry-6, April 10, 1968.

1. *Wealth of India. Raw Materials*, C.S.I.R., New Delhi, 1962, 6, 73.
2. Kirtikar, K. R. and Basu, B. D., *Indian Medicinal Plants*, Lalit Mohan Basu, Allahabad, 1933, 3, 1629.
3. Giboin, L. M., *Epitome de Botanique et de Matière Médicale de l'Inde*, Imprimerie de Sri Aurobindo Ashram, Pondicherry, 1949, p 223.
4. Murti, P. B. R. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1945, 20 A, 266.
5. Agarwal, S. L., Deshmankar, B. S., Verma, S. C. L., and Saxena, S. P., *Ind. J. Med. Res.*, 1960, 48, 463.
6. Paech, K. and Tracey, M. V., *Modern Methods of Plant Analysis*, 1955, 2, 71.
7. *Thorpe's Dictionary of Applied Chemistry*, 1943, 6, 494.
8. Nelson, E. K. and Keenan, G. L., *Science*, 1933, 77, 561.
9. Tarnet, C., *C.R. Acad. Sci.*, Paris, 1907, 145, 1196.
10. Harborne, J. B., *Comparative Biochemistry of Flavonoids*, Academic Press, 1967, p. 209.

## FORMATION OF GLYCOPROTEINS BY RABBIT LIVER SLICES

It was reported,<sup>1</sup> that rat liver slices can utilize added albumin as the sole substrate and that in the incubation medium a protein similar to  $\alpha_1$  globulin in its electrophoretic behaviour was formed. Since glyco- and muco-proteins are also known to have electrophoretic mobilities similar to  $\alpha$  globulins,<sup>2</sup> we thought it would be of interest to investigate this phenomenon further.

Using rabbit liver slices in a similar experiment, the amount of glyco-proteins in an aliquot of the incubation medium drawn at regular time intervals was estimated by the method of Winzler.<sup>3</sup> Both the protein and the protein-bound carbohydrate contents in the perchloric acid soluble-phosphotungstic acid insoluble fraction, were estimated and found to increase with time of incubation (see Table I). Such an increase could not be seen when pyruvate or glycine was used as the sole substrate.

TABLE I  
Formation of glycoproteins by rabbit liver slices

No.	Additions	Time of incubation in hours	Net increase in "Glyco-protein", $\mu$ g./3 ml. of medium*	Net increase in protein-bound carbohydrate $\mu$ g./3 ml. of medium†
1	None (Endogenous)	1	223 (7)	38
2	"	3	756 (5)	127
3	Albumin (15 mg.)	1	4,794 (7)	806
4	"	3	5,816 (5)	1,102
5	Pyruvate (30 $\mu$ M)	1	223 (1)	†
6	Glycine (30 $\mu$ M)	1	1,240 (1)	†
7	Albumin+Pyruvate	1	2,453 (1)	†
8	Albumin+Glycine	1	446 (1)	†

\* Figures in brackets denote the number of experiments. † Not estimated.

The glycoprotein fraction was isolated from the incubation medium of a preparative experiment (consisting of 2.0 g. of tissue slices in 40 ml. of incubation medium and 2 g. of plasma albumin) by the method of Weimer *et al.*<sup>4</sup> The isolated fraction was then subjected to electrophoresis (agar gel, veronal buffer, pH 8.6;  $\mu = 0.5$ ). Two well-defined bands could be detected in the region of  $\alpha$  globulins.

Control experiments were also carried out to ascertain the amount of glycoproteins in the liver before and after incubation. The liver slices were treated with sodium deoxycholate to release all bound proteins into the medium.<sup>5</sup> The results showed that the liver tissue contained only 0.6 mg. protein equivalent of glycoprotein per gram wet weight. It was also observed that a preliminary rinsing of the tissue slices before incubation<sup>6</sup> was necessary to demonstrate a significant increase in the amount of glycoproteins.

At the homogenate level also, such an increase in the formation of glycoproteins could be demonstrated. The system was found to have a requirement for adenosine triphosphate.

These results taken together show that the liver tissue is capable of synthesizing a glycoprotein from albumin.

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Dept. of Biochem., V. N. VISWANATHAN.  
Kasturba Medical M. P. SATHYANARAYANAN.  
College, S. SRINIVASAN.  
Manipal, S.K., March 26, 1968.

1. Roberts, S. and Kelley, M. B., *J. Biol. Chem.*, 1956, **222**, 555.
2. Schmid, K., *J. Am. Chem. Soc.*, 1953, **75**, 60; *Ibid.*, 1955, **77**, 742.
3. Winzler, R. J., In *Methods of Biochemical Analysis*, Edited by Glick, D., Interscience Publishers, 1955, **2**, 279.
4. Weimer, H. E. et al., *J. Biol. Chem.*, 1950, **185**, 561.
5. Peters, T., Jr., *J. Histochem. Cytochem.*, 1959, **7**, 224; Campbell, P. N., In *Protein Biosynthesis*, Edited by Harris, R. J. C., Academic Press, 1961, p. 19.
6. Campbell, P. N. and Stone, N. E., *Biochem. J.*, 1957, **66**, 19.

#### DISTRIBUTION OF ZINC IN THE SUBCELLULAR FRACTIONS OF HUMAN PROSTATE

The presence of considerable quantities of zinc in the prostate gland of different animal species and man has been well documented.<sup>1-6</sup> The present communication deals with localization and concentration of the metal in the subcellular fractions of human prostate.

The prostate of a normal healthy subject (age 35 yr.), who died in a road accident was collected from the air-conditioned municipal

post-mortem room within 24 hr. of death and stored immediately in a deep-freeze. The methods for isolation of subcellular fractions of the prostate, estimation of zinc by polarography, and determination of nitrogen were the same as described previously.<sup>5</sup>

It will be evident from the results presented in Table I that the concentration of zinc

TABLE I  
Subcellular distribution of zinc in human prostate

Fraction	Total nitrogen		Zinc content	
	mg./gm.	% of homogenate	mg./gm. nitrogen	% of homogenate
Homogenate	18.7	..	2.5	..
Nucleus ..	5.1	28.6	2.2	43.5
Mitochondria	3.6	24.4	1.0	19.7
Microsome ..	3.1	9.7	0.42	10.1
Supernatant	4.3	33.5	1.62	30.3

(mg./gm. nitrogen) was highest in the nuclear sediment of the prostate followed by the supernatant, mitochondria and microsome fractions, in diminishing order. The total prostatic content of the metal (calculated as % of homogenate) also recorded higher values for the nuclear and supernatant fraction; the microsomes showed that lowest zinc content on this basis. Thus, the pattern of distribution of zinc in the subcellular fractions of human prostate is virtually similar to that of the rhesus monkey and rat prostate.<sup>5</sup> It is interesting that the concentration of the metal in human and rhesus prostatic fractions is not much different, but that in the rat it is appreciably lower.

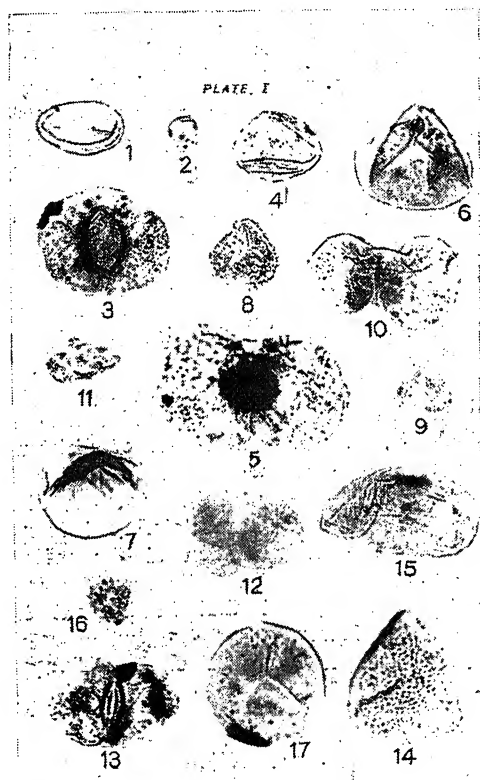
Central Drug Res. Inst., AMIYA B. KAR.  
Lucknow, A. R. CHOWDHURY.  
March 8, 1968,  
(Communication No. 1246).

1. Mawson, C. A. and Fischer, M. I., *Biochem. J.*, 1953, **55**, 693.
2. Gunn, S. A., Gould, T. C. and Ginori, S. S., *Proc. Soc. Exp. Biol. Med.*, 1955, **88**, 556.
3. Kar, A. B., Pover, W. F. R. and Boscott, R. J., *Acta Endocrinol.*, 1956, **22**, 390.
4. Gunn, S. A. and Gould, T. C., *Endocrinol.*, 1956, **58**, 443.
5. Kar, A. B. and Chowdhury, S. R., *J. Urol.*, 1966, **96**, 376.
6. Chowdhury, A. R. and Kar, A. B., *Curr. Sci.*, 1968, **37** (8), 230.

A PRELIMINARY STUDY OF SPORAE  
DISPERSAE IN RAMAGUNDUM  
COALFIELD, GODAVARI COAL  
BASIN, A.P.

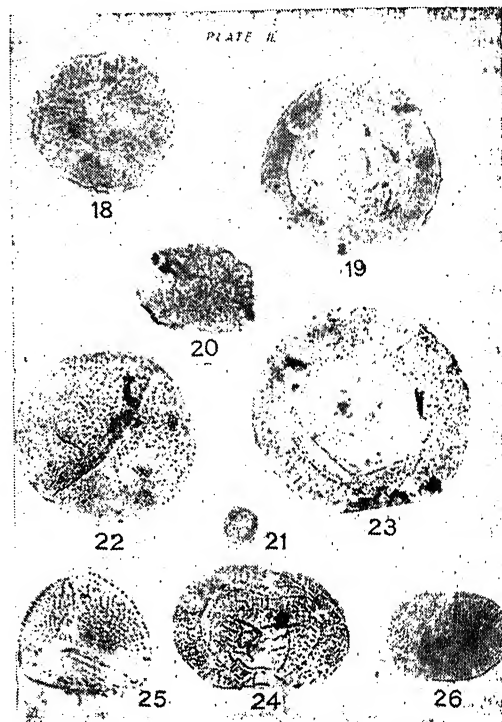
THE present report deals with the miospore assemblage in Coals of Ramagundum Coalfield ( $18^{\circ} 37'-18^{\circ} 45' : 79^{\circ} 25'-79^{\circ} 33'$ ) of Godavari Coal Basin, Andhra Pradesh, India, of which no microfossils is known so far.

The usual techniques, Bharadwaj and Saluja (1964) have been followed for separation of miospores and their qualitative and quantitative study.



FIGS. 1-17. Fig. 1. Latosporites. Fig. 2 Cyclogranisporites. Fig. 3. Cunatisporites. Fig. 4. Welwitschiapites. Fig. 5. Rhizomaspora. Fig. 6. Microfoveolatispora. Fig. 7. Collumispora. Fig. 8. Horriditriteles. Fig. 9. Lophotriteles. Fig. 10. Verticillipollenites. Fig. 11. Striatites. Fig. 12. Lunatisporites. Fig. 13. Primuspollenites. Fig. 14. cf. Microreticulatispora. Fig. 15. Tiwarisporites. Fig. 16. Brevitriteles. Fig. 17. Punctatisporites.

The microflore encountered in these coals is referable to forms of Monoletes, Triletes, Monosaccates and Disaccates along with few Aletes, characteristic of lower Gondwana miospore assemblage, Bharadwaj (1966). This confirms the earlier view that the coal seams



FIGS. 18-23. Fig. 18. Virkipollenites. Fig. 19. Parasaccites. Fig. 20. Indotiradites. Fig. 21. Fungal Spore. Fig. 22. Sulcatisporites. Fig. 23. Plicatipollenites. Fig. 24. Striatopodocarpites. Fig. 25. Microbaculispora. Fig. 26. Faunipollenites. (All Figures,  $\times 250$ ).

in Godavari Valley coalfields are concealed in the lower Gondwana strata, Fox (1934). The following spore genera have been recorded.

OBSERVATION

Horriditriteles Bharad. and Saluja.  
Sulcatisporites Leschik.  
Brevitriteles (MS) Bharad. and Srivast.  
Primuspollenites Tiwa.  
Microfoveolatispora Bharad.  
Lophotriteles (Naum) Pot. and Kr.  
cf. Microreticulatispora Bharad.  
Punctatisporites (Ib) Pot. and Kr.  
Latosporites Pot. and Kr.  
Indotiradites Tiwa.  
Tiwarisporites Mahesh. and Kar.  
Illinites (Kos) Pot. and Kr.  
Collumispora (MS) Bharad. and Srivast.  
Parasaccites Bharad. and Tiwa.  
Virkipollenites Lele.  
Cyclogranisporites Pot. and Kr.  
Vesicaspora (Schemal) Wils and Venkata.  
Cunatisporites Leschik.  
Rhizomaspora Wils.

Verticipollenites Bharad.  
Lunatisporites (Leschik) Bharad.  
Striatites Pant.  
Vittatina Lubér.  
Welwitschiapites Bolc.  
Faunipollenites Bharad.  
Striatopodocarpites (Soritsch and Sed.)  
Bharad.  
Pilaspores Balm and Hen.  
Plicatipollenites Lele.  
Microbaculispora, gen. nov.  
Potonisporites Bharad.  
Lahirites Bharad.

Some of the important genera are illustrated in Plates I and II.

Department of Geology, A. A. Moiz.  
Osmania University, N. RAMANA RAO.  
Hyderabad-7, December 18, 1967.

1. Bharadwaj, D. C., *Symp. Floristics, Strtigr. of Gondwan*, Sah i Inst., 1966, pp. 69-81
2. — and Salu ha, S. K. *Palaeobotanist*, 1961, 12 (2)
3. Fox, C S., *Niem. G.S.I.*, 934, 59.
4. Navale, G. K B. and Tiwari, R. S., *Jour. Geol. Soc. Ind.*, 1967, 8, 68.
5. Srivastava, S. C., *Ph.D. Thesis submitted to Lucknow University*, 1967 (Unpublished).

### ABNORMAL GROWTH OF LOWER INCISORS IN *RATTUS RATTUS*

THE cause of abnormal growth of incisors in rodents is not properly known. Young (1950)<sup>1</sup> thinks that it is due to the rootless nature of the incisors causing continual growth. Bagh (1964)<sup>2</sup> reported a case of abnormal growth of lower incisors in *Rattus rattus*. Bagh and Bhaduri (1964)<sup>3</sup> attribute such growth to genetic mutation. Vanchinathan (1964)<sup>4</sup> considers that fluorine imbalance may be a cause. Mitchell (1964)<sup>5</sup> opines that it is due to non-functional jaw muscles (Fig. 1).

Recently I have been able to collect two living specimens of *Rattus rattus* showing the abnormal growth of lower incisors from Suri, Birbhum, W. Bengal, with the help of two students. I may mention that I collected one specimen of *R. rattus* showing the same abnormality from the same place in 1964. The following observations were made:

#### OBSERVATION (FIG. 2)

No. of specimens observed—2			Sex—male
Size	Body	Tail	Length of lower incisors
Specimen No. 1	3.8"	3.1"	1.8"
do. 2	5.7"	4.4"	1.5"

It was observed that the animals refused to take hard food (unboiled rice, gram, peas), but preferred the soft ones (bread, boiled rice, etc.). They felt uneasy while taking food and it was observed that they tried in vain to break those abnormal teeth.



FIG. 1. Showing the abnormal growth of both the lower incisors in *Rattus rattus*. Note the curved, well-developed teeth.

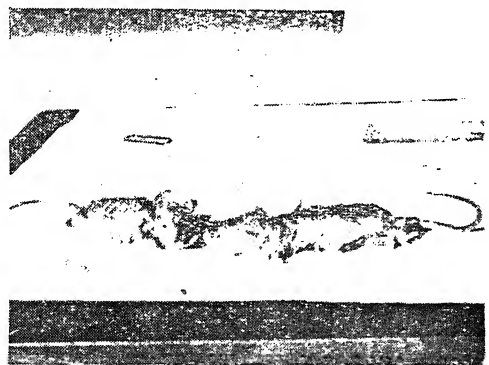


FIG. 2. Showing the abnormal growth of lower incisors in younger specimens.

Unfortunately the specimen No. 1 survived for 6 days and No. 2 for 7 days only in spite of the best care taken.

The abnormal growth of the lower incisors in those specimens may be due to deleterious mutation. If fluorine imbalance is the cause then other deformity or pathogenic condition should also be there. It may be noted that only the lower incisors were affected.. The jaw muscles were active and thus it ruled out the possibility that this phenomenon is associated with ineffective jaw muscles.

Zoology Department,  
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Suri, Birbhum, W. Bengal,  
March 21, 1968.

R. K. BAGH.

1. Young, J. Z., *The Life of Vertebrates*, 1950.
2. Bagh, R. K., *Amrita Bazar Patrika*, Calcutta.  
December 15, 1964.
3. Bhaduri, P. K., *Ibid.*, December, 1964.
4. Vanchinathan, K., *Ibid.*, December, 1964.
5. Mitchell, C. J., *Ibid.*, December 1964.

### MARINE FUNGI

MARINE lignicolous fungi have been collected in the coastal waters of some thirty-six countries. However, records and observations on marine fungi have been largely from Australia, France, Germany, Great Britain and the U.S.A. (Jones, 1968). Little is known of marine fungi off the coasts of India, Aden and Singapore. Becker and Kohlmeyer (1958) recorded the presence of soft rotting fungi on small fishing craft in India. The only species named was *Halosphaeria quadricornuta*. Almieda (1963) in a preliminary investigation of micro-organisms on timber in Indian

coastal waters listed a number of bacteria and a few fungi: (*Aspergillus* sp., *Cladosporium* sp. and *Halosphaeria quadricornuta*). Three further marine fungi have been described from India, *Paralichomyces letiferus* (Kohlmeyer, 1959), *Corollospora pulchella* and *Clavariopsis bulbosa* (Kohlmeyer, Schmidt and Nair, 1967).

The materials and methods used are similar to those described by Jones (1963), copper wire being replaced with 'Courlene' nylon rope. Testing sites were situated at the I.N. Physical Laboratory, Cochin, India; Naval Chemical and Metallurgical Laboratory, Naval Dockyard, Bombay, India; Material Laboratory, Engineering Department, H.M. Dockyard, Singapore and at Slave Island, Aden Harbour, Aden.

The results are summarised in Table I.

In comparison to other studies of this kind (Jones, 1963; Meyers and Reynolds, 1960) the number of fungi recorded was low at all the stations tested. This may be due to the very rapid deterioration of the wood by the animal borers and bacteria. A successional pattern of fungi as reported by Jones (1963) was not observed. *L. floridana* and *H. quadricornuta* would seem to be quite common. These two

TABLE I

Infestation of beech (B) and Scots pine (SP) test block at Aden, Cochin, Bombay and Singapore

	6 weeks								12 weeks								18 weeks			30	36	42	Total	
	Aden		Cochin		Bombay		Singapore		Aden		Cochin		Bombay		Singapore		Cochin		Cochin		Cochin			
	B	SP	B	SP	B	SP	B	SP	B	SP	B	SP	B	SP	B	SP	B	SP	B	SP	B	SP		
FUNGI																								
FUNGI IMPERFECTI																								
1. <i>Humicola alogallonella</i> Meyers & Moore	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	*1	-	-	-	-	2
2. <i>Humicola</i> sp.	+	-	+	+	-	-	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	22
3. <i>Cirrenalia mucrocephala</i> (Kohlm.) Meyers & Moore	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	+	+	+	+	-	5
ASCOMYCETES																								
4. <i>Lulworthia floridana</i> Meyers	+	-	+	+	+	+	+	+	+	-	+	-	+	+	-	-	-	-	..	+	+	+	-	14
5. <i>L. purpurea</i> (Wilson) Johnson	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	-	-	-	-	-	4
6. <i>Halosphaeria quadricornuta</i> Cribb & Cribb	-	-	-	-	+	-	-	-	+	+	-	-	+	+	+	-	-	+	+	+	+	+	+	15
Soft Rot attack	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	..
<i>Teredo</i> sp. attack	-	-	-	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	22
<i>Limnoria</i> sp. attack	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	..	+	+	+	-	2
<i>Martesia striata</i>	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	+	+	+	+	+	+	10

B=Beech, SP=Scots Pine,

\*1=Test block completely destroyed by borer attack.



Ascomycetes have a wide distribution as indicated by Jones (1968). *L. floridana* being known from 7 countries and *H. quadricornuta* from 16 countries. There is some evidence that *H. quadricornuta* prefers warmer waters, and at present, is not known from the Northern hemisphere. Clearly further work on the distribution of marine fungi in Indian coastal waters is called for.

It is a pleasure to thank the following for all their help with this work, Officer-in-Charge, Cochín Physical Laboratory; Officer-in-Charge, H. M. Dockyard, Singapore; D. R. Houghton, Central Dockyard Laboratory, Portsmouth; R. I. Currie, National Institute of Oceanography, Godalming and especially S. K. Ranganathan, Officer-in-Charge, Naval Dockyard, Bombay.

Dept. of Biological Sciences,  
College of Technology,  
Portsmouth, England, May 8, 1968.  
E. B. GARETH JONES.

1. Almieda, I. J., *Study of Micro-organisms in Relation to Attack of Timber by Marine Borers and Fouling Organisms*, Report No. NCML/5/63, Naval Chemical and Metallurgical Laboratory, Naval Dockyard, Bombay, 1963.
2. Becker, G. and Kohlmeyer, J., "Deterioration of wood by marine fungi in India and its special significance for fishing craft," *Jour. Timber Dryers and Preservers*, India, 1958, 4, 1.
3. Jones, E. B. G., "Observations on the fungal succession on wood test blocks submerged in the sea," *Jour. Institute of Wood Sci.*, December, 1963, No. 11 p. 14
4. —, *The Distribution of Marine Fungi on Wood Submerged in the Sea. 1st International Biodeterioration Symposium*, Southampton, 1968 (In press).
5. Kohlmeyer, J., Schmidt, I. and Nair, N. B., "Eine neue *Corallispora* (Ascomycete) aus dem Indischen Ozean und der Ostsee," *Res. dt. Bot. ges.*, 1967, 80, 98.
6. Meyers, S. P. and Reynolds, E. S., "Occurrence of lignicolous fungi in Northern Atlantic and Pacific marine localities," *Can. J. Bot.*, 1960, 38, 217.

#### INVERSE RELATIONSHIP BETWEEN RESISTANCE TO RUSTS AND LEAF BLIGHT IN WHEAT

DURING the past few years, dwarf and semi-dwarf varieties of wheat with the desired morphological and physiological make-up necessary for a high degree of resistance to rusts as well as for high yields, have been evolved by genetic engineering. The changing agronomy in wheat cultivation and the rapid replacement of many locally adapted varieties with a few high-yielding ones are

already creating new disease problems which were hitherto unimportant or insignificant. For example, leaf blight of wheat caused by *Alternaria trititica* Prasada and Prabhu is now well established in almost all the wheat-growing regions of the country as a result of a rapid shift in varieties to those more susceptible to this disease. This disease is not entirely new to India and there is enough evidence in literature that it has been in existence since 1924. Apparently, it was never a serious threat to the wheat crop and little or no effort was made to study the etiology of the disease till very recently. The Kenphad varieties in Maharashtra, NP 400 strains in Madhya Pradesh and the high-yielding and rust-resistant Mexican dwarfs such as Sonora 64, V.18 and S227, have proved to be susceptible to leaf-blight. The variety NP 830, which showed a high degree of resistance to black rust and was particularly suitable for late sowing in Uttar Pradesh, became highly susceptible to leaf-blight disease and had to be withdrawn from the recommended list. Conversely, highly rust-susceptible varieties like Agra local and *Triticum vavilovi* are resistant to leaf-blight.

The coincident susceptibility to rust and resistance to leaf-blight in wheat has a parallel in oat varieties where susceptibility to *Helminthosporium victoriae* Meehan, and Murphy and resistance to *Puccinia coronata* (Pers.) Eda, appear to be always associated. Horsfall and Dimond<sup>2</sup> based on the findings of various workers categorized diseases into low sugar and high sugar diseases. According to them, the low sugar content of Victoria-based oat varieties determine the susceptibility to *Helminthosporium* leaf-blight and resistance to crown rust. Leaf-blight of wheat falls under the "low sugar" class of diseases, while rusts fall under the "high sugar" class. The success of a parasite, whether it is *Puccinia* spp. or *Alternaria* spp., is ultimately related to its ability to thrive in the nutrient environment of the host. A close correlation was found by Reddy<sup>3</sup> between the sugar levels in stem and leaves and disease intensity in the case of the wheat leaf-blight disease. If the content of non-reducing sugar was low, the disease incidence was high and *vice versa*. NP 823 which is resistant to leaf-blight has a relatively high non-reducing sugar content, in comparison with the susceptible strain NP 830. Disease development was retarded in NP 830 when the plants were artificially fed with sucrose. Treat-

ment with the growth hormone 2, 4-D which is known to deplete the carbohydrates, increased the susceptibility to leaf-blight.

Treatment of a local wheat variety, Motia, which is susceptible to both black rust and leaf-blight with maleic hydrazide caused increased development of rust but very little or no development of blight. Such treatments which increase or decrease the sugar levels produce a state of predisposition in the tissue for one or the other disease.

From the available evidence, it appears that an important factor in the development of leaf-blight of wheat is the pattern of sugar metabolism and translocation. Early-maturing varieties such as Sonora 64 and Sonalika are more prone to attack by leaf-blight than the late-maturing varieties like NP 824 and Lerma Rojo. Carbohydrate changes also occur in the host tissue with different agronomic practices. An increased application of nitrogenous fertilizer has been found to be linked with decreased tolerance to leaf-blight.<sup>4</sup> The dwarf high-yielding wheat varieties seem to offer cellular substrate conditions which are favourable to leaf-blight, because of the rapid translocation of soluble sugars from the foliage to the ear.

It is hence necessary to isolate a source of resistance to leaf-blight which checks the spread of the pathogen in the host through a pathway independent of cellular sugar levels. That this may be possible is evident from the isolation of oats strains which are simultaneously resistant to both crown rust and Victoria blight.<sup>5</sup>

Indian Agri. Res. Inst., A. S. PRABHU.  
New Delhi, M. S. SWAMINATHAN.  
April 11, 1968.

1. Prabhu, A. S. and Prasada, R., *Indian Phytopath.*, 1966, **29**, 95
2. Horsfall, J. G. and Dimond, A. E., *Zeitschrift Für Pflanzenkrankheiten*, 1967, **64**, 415.
3. Reddy, A. P. K., *Ph.D. Thesis*, Post-graduate School, Indian Agricultural Research Institute, New Delhi, 1967 (Unpublished).
4. Prabhu, A. S. and Prasada, R., *International Plant Pathological Symposium*, New Delhi, December 27, 1966 (Abstr.).
5. Welsh, J. N., Peterson, B. and Machacek, J. E., *Can. J. Bot.*, 1954, **32**, 55.

### CLUSTER MUTATIONS AS AN INDEX OF PENETRATION-COEFFICIENT AND DELAYED EFFECT OF MUTAGENS

CLUSTER mutation is a term used by Gaul<sup>1</sup> for those mutations which arise in the progenies of different spikes or branches, and which are phenotypically similar. Monti and Scarascia Mugnozza<sup>2</sup> found that 61.36% of such mutations in pea are of independent origin and therefore fall in the group of multiple mutations described by Sharma.<sup>3</sup>

The present studies were carried out using a wide range of doses of gamma-rays (G), ethylmethane sulphonate (EMS) and N-nitrosomethyl urea (NMU) for treatment of pre-soaked (20 hr.) and dry seeds of paddy variety IR 9-60. The progenies of five randomly selected tillers of each  $M_1$  plant were raised in  $M_2$  for scoring chlorophyll mutations. The data presented here include mostly *albina* mutations and a few cases of *xantha*, *viridis* and *albo-viridis*.

The frequency of cluster mutations induced by the three mutagens, and the effect of pre-soaking on their appearance is shown in Table I.

TABLE I  
Frequency of cluster mutations induced by gamma-rays (G), ethylmethane sulphonate (EMS) and nitrosomethyl urea (NMU), and the effect of pre-soaking on their appearance

Mutagen and type of seed	Total no. of plant progenies in $M_2$	% of mutated plant progenies having cluster mutations	Total no. of spike progenies in $M_2$	% of mutated spike progenies sharing cluster mutations
G	289	37.2	1377	60.9
EMS	339	21.8	1641	41.0
NMU	382	40.7	1863	60.4
Pre-soaked	560	27.6	2786	49.3
Dry	450	41.1	2113	61.3

It would be seen that the frequency of cluster mutations calculated on the basis of  $M_1$  plants or spikes gives the same result: their frequency is almost equal in the treatments of gamma-rays and NMU, and EMS induced about 32% less cluster mutations (on spike basis). These findings are in concurrence with the results obtained by Swaminathan *et al.*<sup>4</sup> and Savin *et al.*,<sup>5</sup> who showed that the segregation ratio of mutants in  $M_2$  was highest in the treatments of NMU, and this being a reflection of the increased size of mutated

sector in the  $M_1$  plants. In the present experiments, the spikes sharing cluster mutations can be treated as participants of a single mutated sector of the treated embryo.

The differences in the frequency of cluster mutations may be attributed to two main factors: the rate of penetration of the mutagen through the seed tissue and the time taken by the mutagen to induce mutation after it has come in contact with the genic material. The data in Table I also show that the frequency of cluster mutations is about 25% more (on spike basis) when dry seeds are treated as compared to the treatment of seeds pre-soaked in water for 20 hours. This holds true for all the mutagens studied here. Since the penetration of mutagenic solution is quicker in pre-soaked seeds, the high frequency of cluster mutations after dry seed treatment should be attributed to factors other than the penetrability of seed tissues. The initiation of cellular activity caused by pre-soaking perhaps leads to an increased number of embryonic cells before the mutation-induction takes place, which results in the reduction in the frequency of cluster mutations.

Gamma-rays are likely to induce more cluster mutations owing to their unrestricted penetration through the seed tissue and relatively quicker effect on chromosomes than most of the chemicals. But NMU also induces a high frequency of cluster mutations almost equal to that of gamma-rays. It seems probable that such a high rate of cluster mutations obtained with NMU in contrast to EMS may be a result of the combined effect of three different phenomena, i.e., quicker penetration, immediate effect on chromosomes and induction of multiple mutations with similar phenotypic expression. The extent of these three effects can be determined on the basis of large data collected from specially planned experiments. Since even the multiple mutations are considered to be associated among themselves (Sharma and Orav<sup>6</sup>), it will not be easy to distinguish them from the true cluster mutations originating from a single cell in the treated embryo.

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Division of Genetics, B. SHARMA.  
I.A.R.I., New Delhi, February 21, 1968.

1. Gaul, H., *Induction of Mutation and Mutations Process*, Prague, 1965, p. 62.
2. Monti, L. M. and Scarascia Mugnozza, G.T., *Atti. Ass. Genet. It.*, Pavia, 1964, 9, 115.
3. Sharma, B., *Genetics (USSR)*, 1966, 1, 45.
4. Swaminathan, M. S., Siddiq, E. A., Savin, V. N. and Varughese, G., *Symp. Use of Induc. Mut. in Pl. Breed.*, 1967, IAEA, Vienna (in press).
5. Savin, V. N., Swaminathan, M. S. and Sharma, B., *Mut. Res.*, 1968 (in press).
6. Sharma, B. and Orav, T., *Izvestia Acad. Sci. Eston. SSR (Biol. Ser.)*, 1965, 4, 471.

### IN SUPPORT OF THE SEPARATION OF *CASSIA TORA* L. AND *C. OBTUSIFOLIA* L. AS TWO DISTINCT TAXA

The simultaneous publication of *Cassia tora* and *C. obtusifolia* by Linnaeus<sup>1</sup> as two distinct species was followed by the reduction of *C. obtusifolia* L. as a synonym of *C. tora* L. by Bentham.<sup>2</sup> Since then these two species have received confused treatment by taxonomists, being regarded by some as synonyms<sup>3,5</sup> while by others as distinct species.<sup>6,9</sup> During an ecological study of these species some experimental evidence has been gathered to indicate that these are distinct taxa and the same is briefly discussed in this communication. Details will be published elsewhere.

Seeds of both the species were obtained from three different localities, viz., Ahmedabad, Ujjain and Sagar in January, 1965 and plants were raised from these seed stocks in the botanical garden of the Banaras Hindu University under uniform culture conditions. When the plants were 30 days old data on their growth performance were recorded. For identification of the two species, characters described by Brennan<sup>9</sup> were followed. Mature seeds of the two species were also stored for one year at different temperatures ( $-15^{\circ}\text{C.}$  to  $30^{\circ}\text{C.}$ ) and then the same were germinated at  $30^{\circ}\text{C.}$  which is the most suitable temperature for germination of these seeds<sup>10</sup> to record the germination percentage.

It is apparent from Table I that values recorded for all the five characters in the case of *C. obtusifolia* are higher than the corresponding values for *C. tora*. The differences in the characters of the two species are statistically significant except for root penetration. This observation is contrary to that of Mall<sup>11</sup> who observed no difference in the height of the plants of these species in field. The response to uniform culture of plants of the two taxa from the same place is not uniform. For example, *C. obtusifolia* originating from

TABLE I  
Growth performance of *C. tora* and *C. obtusifolia* under uniform culture

Character	<i>C. tora</i>			<i>C. obtusifolia</i>			Significance
	Ahmedabad	Sagar	Ujjain	Ahmedabad	Sagar	Ujjain	
Height (cm.)	11.20	11.12	14.10	20.48	20.74	20.38	***
Root penetration (cm.)	14.54	17.60	20.30	18.68	20.74	16.90	NS
Dry weight shoot (g.)	1.980	0.542	2.462	3.596	2.130	3.520	**
Dry weight root (g.)	0.096	0.092	0.078	0.148	0.154	0.166	***
Pod length (cm.)	10.10	11.20	9.60	10.60	14.10	13.40	***
No. seeds/pod.	15.73	17.80	14.30	15.70	21.03	22.20	***

NS=Not significant, \*\*  $P < 0.01$ , \*\*\*  $P < 0.001$ .

Sagar shows maximum height while in *C. tora* the tallest plants are those of Ujjain origin. From this experiment it is clear that *C. obtusifolia* is decidedly a more robust plant than *C. tora* and that their response to uniform culture is not similar. This type of behaviour is due to genetic difference in the populations as argued by Vaartaja<sup>12</sup> and McMillan.<sup>13</sup>

The records of germination percentage (Table II) indicate that germinability of *C. tora* is considerably lower than that of *C. obtusifolia*. Further, there is a consistent increase in the germination of *C. tora* with increasing storage temperature, the values for lower temperatures being very low. In *C. obtusifolia*, on the other hand, germinability is indifferent to storage temperature.

TABLE II

Percentage germination of seeds at 30° C. after one year storage at different temperatures (May-June, 1966)

Storage temperature	<i>C. tora</i>	<i>C. obtusifolia</i>
15° C. (for 2 months, later changed to 0° C.)	7.5	60
0° C.	8.5	54
10° C.	10.5	57
20° C.	19.5	63
30° C.	39.5	68

This experiment indicates that *C. obtusifolia* is more flexible to environmental conditions and thus supports the conclusion of Irwin and Turner.<sup>14</sup> The wider distribution of *C. obtusifolia* both in New and Old World is probably due to this behaviour. Cumming<sup>15-16</sup> found that the species which have more specific temperature requirement for germination are more restricted in distribution than those which have a wider amplitude. *C. tora* shows narrowing of optimal storage temperature and probably as a consequence is restricted to Old World.<sup>9</sup>

I conclude, therefore, that these two taxa are distinct and may represent two distinct species as argued by Mall.<sup>11</sup>

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Department of Botany, J. S. SINGH,  
Banaras Hindu University,  
Varanasi-5, March 26, 1968.

1. Linnaeus, C., *Species Plantarum*, 1753, p. 376 & 377.
2. Bentham, G., *Principes Univ. Sci. London*, 1871, 27, 535 & 536.
3. Hooker, J. D., *The Flora of British India* L. Reeve and Co., 1879, 2.
4. Bamber, C. L., *Plants of the Punjab*, Govt. Printing Press, Lahore 1916.
5. Jackson, B. D., *Index Kewensis*, Clarendon Press, Oxford, 1813, 1.
6. Roxburgh, W., *Flora Indica*, Thacker and Spink & Co., 1832.
7. Prain, D., *J. Asiatic Soc. Bengal*, 1897, 66, 417.
8. De Wit, H. B., 1965, 11, 255 & 277.
9. Brevan, J. P. M., *Kew Bull.*, 1958, 1, 231.
10. Singh, J. S., *P.L. 180 Ecology Ann. Rep., B.H.U.*, 1967, p. 4.
11. Mall, L. P., *J. Univ. Sagar*, 1957, 6, 35.
12. Vaartaja, O., *Ec. Monogr.*, 1959, 29, 91.
13. McMillan, C., *Ibid.*, 1959, 29, 285.
14. Irwin, H. S. and Turner, B. L., *Amer. J. Bot.*, 1960, 47, 309.
15. Cumming, B. G., *Nature*, 184, p. 1041.
16. , *Proc. North Cent. Weed. Control Conf.*, Milwaukee, Wisconsin, 1960, p. 39.

#### A NEW HYPOTHESIS TO ACCOUNT FOR THE OPPOSITE TROPHIC-BIOMASS STRUCTURE ON LAND AND IN WATER

While discussing the Y-shaped energy flow model, Odum<sup>1</sup> states that the marine community holds a relatively large standing crop of animals compared to that of plants (phytoplankton). The situation is reversed in terrestrial communities which maintain a larger biomass of the plants. Phillipson<sup>2</sup> while comparing the biomass pyramids of trophic level for terrestrial and some aquatic ecosystems,<sup>3</sup> showed the same phenomenon by drawing an upright pyramid for land and an inverted pyramid for

aquatic situations. One of the factors causing this inverse relation between the two habitats may be the difference in the energy flow pathway. For example, in marine community the grazing pathway is more efficient while in the forest community the detritus pathway is predominant.<sup>1</sup> But as Odum<sup>1</sup> further contends, this difference may not necessarily be inherent in aquatic and terrestrial ecosystems. In grasslands, for example, the grazing pathway is very conspicuous and in certain cases as much as 88% of the produce is removed for livestock consumption within a short period,<sup>4</sup> and yet the trophic-biomass pyramid is not inverted. It is obvious, therefore, that an explanation for this paradox has to be found in altogether different quarters.

The most significant difference in the aquatic and terrestrial ecosystems is that the variations in the oxygen concentration of the gaseous medium on the land are much less and being in abundance it ordinarily never becomes a limiting factor for respiration<sup>5</sup> of terrestrial communities. The much limited oxygen concentration of the aquatic environment, on the other hand, exhibits greater fluctuation both seasonally<sup>6,7</sup> and diurnally.<sup>8,9</sup> The limited supply of oxygen in water is causal to many physiological adaptations of the biota. The various animals, therefore, have been labelled as oxygen regulators or oxygen conformers.<sup>10</sup>

One of the major sources of energy dissipation is respiration. A survey of the literature<sup>11-15</sup> indicates that the rate of respiration or energy dissipation is lower in the case of aquatic animals than in the terrestrial ones (Table I). Further, in the latter case the respiration may increase manifold during period of activity. For example, in man, rate of energy dissipation through respiration may go up 15-20 times than the resting value; and in insects, flight may cause 50-200 times increase.

TABLE I  
Rate of respiration of some aquatic and terrestrial animals at rest

Aquatic		Terrestrial	
Animals	Range of O <sub>2</sub> consumption (mg./g. wt./hr.)	Animals	Range of O <sub>2</sub> consumption (mg./g. wt./hr.)
Fishes	0.005-0.349	Mammals	0.124-13.70
Insects	0.112-0.381	Birds	1.50-10.70
Crustaceans	0.05-0.11	Insects	0.63-1.70
Molluscs	0.002-0.186	Arthropods	0.27-7.40
Worms	0.008-0.031		

However, the active metabolism of fish may increase only 4 times the rest metabolism.<sup>12,16-17</sup> Thus both in rest and activity the energy loss of aquatic animals is smaller. Moreover, considerably greater species diversity of terrestrial ecosystem<sup>18</sup> leads to more efficient loss of energy. Now, Patten<sup>19</sup> has shown "if more information is accumulated than used, the excess is converted to biomass". Hence, the inverted trophic-biomass pyramid in marine ecosystems is primarily due to slower energy dissipation of animals *via* respiration as compared to terrestrial ecosystems. This leads to greater build-up of consumer biomass in the former system. Indeed the conservation of biomass at the consumer levels is possible on account of rapid turnover of the producer system and hence the trophic-biomass structures of the aquatic and terrestrial ecosystems have evolved primarily, on the basis of oxygen tension of the two media.

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Varanasi-5 (India),  
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J. S. SINGH.  
K. P. SINGH.

1. Odum, E. P., *Ecology*, Holt, Rinehart and Winston, Inc., 1963.
2. Phillipson, J., *Ecological Energetics*, Edward Arnold Ltd., 1966.
3. Odum, E. P., *Fundamentals of Ecology*, W. B. Saunders Co., 1959.
4. Singh, J. S., *Ph.D. Thesis*, Banaras Hindu University, 1967.
5. Meyer, B. S., Anderson, D. B. and Bohning, R. H., *Introduction to Plant Physiology*, Van Nostrand & East-West Press, 1963.
6. Petersen, W., *Ecology*, 1926, 7, 371.
7. Singh, V. P., In *Proc. on Symp. Algology*, Edited by Kachroo, P., I.C.A.R., New Delhi, 1959, p. 243.
8. Broekhuysen, G. J., *Arch. Neer Zool.*, 1935, 2, 257.
9. Ganapati, S. V., In *Proc. on Symp. Algology*, Edited by Kachroo, P., I.C.A.R., New Delhi, 1959, p. 264.
10. Prosser, C. D. and Brown, F. A., Jr., *Comparative Animal Physiology*, W. B. Saunders Co., 1962.
11. Bishop, D. W., *Ibid.*, Edited by Prosser, C. L., W. B. Saunders Co., 1950, p. 209.
12. Fry, F. E. J., In *The Physiology of Fishes*, Edited by Brown, M. E., Academic Press, Inc., New York, 1957, p. 1.
13. Golley, F. B., *Ecol. Monogr.*, 1960, 30, 187.
14. Engelmann, M. D., *Ibid.*, 1961, 31, 321.
15. Kanango, M. S. and Prosser, C. L., *Jour. Cell and Comp. Physiol.*, 1959, 54, 259.
16. Fry, F. E. J., *Publ. Ontario Fish. Res. Lab.*, 1947, 68, 1.
17. — and Hart, J. S., *Biol. Bull.*, 1948, 94, 66.
18. Hutchinson, G. E., *Amer. Nat.*, 1959, 93, 145.
19. Patten, B. C., *Ecology*, 1959, 40, 221.

### THE COLONIZATION OF *ANOPHELES TESSELLATUS* THEO., 1901

CHITTOOR virus a member of Bunyamwera group of arboviruses has repeatedly been isolated from *Anopheles tessellatus*.<sup>1,2</sup> To study the role of *A. tessellatus* in the maintenance and transmission of Chittoor virus, the necessity of colonization of this species in the laboratory was felt. Very few species of anopheline mosquitoes have so far been colonized in India,<sup>3-5</sup> of which *Anopheles stephensi* has been extensively colonized in various laboratories for experimental purposes.<sup>5</sup> Recently there has been a report on the colonization of *Anopheles subpictus* in Pakistan.<sup>6</sup> This communication describes the colonization of *A. tessellatus* in the laboratory.

The colony was started with field collected fed females of *A. tessellatus*. In the laboratory they were held in a cage 30" × 24" × 24" kept in an insectary maintained at 30° C. and 80-85% relative humidity. Lighting in the insectary was provided with four 40-watt fluorescent tubes, 13 hr. "daylight" period and 11 hr. dark period was automatically controlled with a time clock.

The adult mosquitoes were fed on slices of ripe banana and raisins soaked in water. A shaved rabbit was put in the cage every night in the beginning, for blood feed and later on, when the number of mosquitoes in the cage increased, the rabbit for the blood-meal was provided on alternate nights. For oviposition, open-water pan and a wet filter-paper in the form of cone were provided. In the earlier stages the females oviposited on the filter-paper, but later adapted to oviposit in the water pan. Eggs were removed on every third day. The eggs were hatched in 1 to 2% salt solution, as in ordinary tap-water the hatching was erratic and took longer time.

Larvæ were reared in 16" × 9" × 2" enamel pans of tap-water and fed on dried brewer's yeast. The water in the larval pans was aerated with air pump continuously. Pupæ were removed daily from the larval pans and transferred to the cage for emergence into adults.

This colony has been maintained in healthy state for the last two years without any major trouble and at any time 2,000 to 3,000 adult mosquitoes are present in the cage. The generalized life-cycle is about 16 to 22 days: egg 3-4, larva 7-9, pupa 1-2, adult (from emergence to first oviposition) 5-7 days.

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Poona-1, India, April 5, 1968.

1. Singh, K. R. P. and Pavri, K. M., *Ind. Jour. Med. Res.*, 1966, **54**, 220.
2. Virus Research Centre, Unpublished data.
3. Russell, P. F. and Mohan, B. N., *J. Mal. Inst. Ind.*, 1939, **2**, 432.
4. Mohan, B. N., *Ibid.*, 1945, **6**, 75.
5. Ward, R. A. and Kitzmiller, J. B., *Mosq. News*, 1963, **23**, 291.
6. Ludlam, K. W., *Ibid.*, 1966, **26**, 427.

### AN IMPROVED TECHNIQUE FOR INDUCTION OF POLYPLOIDY IN GRAPES

DERMEN<sup>1</sup> suggested treatment with colchicine of three axillary buds in a single decapitated shoot of Grape plant for induction of polyploidy and obtained 20% recovery. Following this technique Das and Mukherjee<sup>2</sup> obtained 29.1% recovery. In a trial with 369 shoots, they observed that mostly the topmost bud (about 60%) was affected, and the chances of induction were 1.3 buds per plant. Further work in this laboratory indicated that a better method would be allowing three shoots to grow from a cutting and treating only one bud from each shoot.

Each of three shoots retained per plant was cut back to a healthy bud in April, removing all the lower buds. The single top bud was treated the next day with 0.5% colchicine by the method recommended by Das and Mukherjee. For comparison, three buds on each shoot were similarly treated in the controls. While 55% of the shoots in the control yielded tetraploids, all the shoots treated by the single-bud method yielded tetraploids in the variety Bhokri. On the basis of buds only 17.5% of those treated by the three-bud method yielded tetraploids, while all the buds treated by the single-bud method gave rise to tetraploids. The main reason for the better success in this method appears to be due to the greater vigour imparted to the treated bud, on account of all the leaves nurturing it, while in the three-bud method, all the three buds have to share the nutrition supplied by the leaves on a single shoot till the buds have produced their own leaves. The greater number of affected leaves per shoot (6.0) in this method than in the three-bud method (4.7) indicated a better penetration of

colchicine which must have been due to a more rapid initiation of internodal elongation within the bud.

When experimental material is limited, as in hybrids requiring polyploidization, this method offers a more assured success.

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Indian Agricultural Res. S. K. MUKHERJEE.

Institute,  
New Delhi, March 12, 1968.

1. Dermen, H., *J. Hered.*, 1954, 45, 159.
2. Das, P. K. and Mukherjee, S. K., *Indian J. Genet.*, 1967, 27, 107.

### OBSERVATIONS ON FEMALE GAMETOGENESIS IN *SYNEDRELLA* *NODIFLORA* GAERTN.

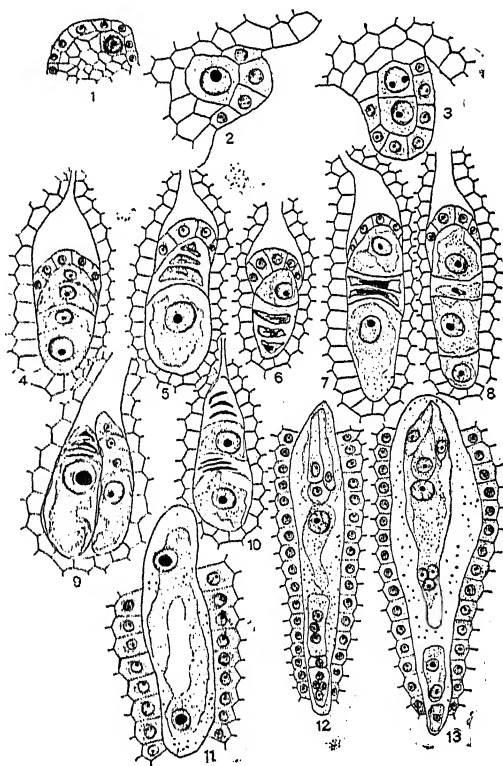
EMBRYOLOGICAL studies of Compositae are of great interest because of the numerous variations noticed in the embryo-sac, embryo, antipodals and synergids.<sup>1,2</sup> The present investigation deals with the development of female gametophyte in *Synedrella nodiflora* Gaertn. Material was collected around Bangalore and the heads were fixed in F.A.A. Sections of capitula were cut at 8 to 12 $\mu$  and stained with Heidenhain's iron haematoxylin.

*Synedrella nodiflora* belongs to the tribe Heliantheae. Heads are heterogamous. Achenes are of two distinct types. Those of the ray florets are dorsally compressed and winged, and those of the disc florets slender, ridged with a pappus of two awns.

The ovule in the inferior, bicarpellary, unilocular ovary is anatropous, unitegmic and tenuinucellate with a massive integument. When the nucellus is still erect a hypodermal archesporial cell differentiates which directly functions as the megaspore mother cell (Figs. 1-2). The megaspore mother cell reaches its maximum size when the overgrowth of the integument is completed. The megaspore mother cell undergoes the usual meiotic divisions to give rise to a linear tetrad (Figs. 2-4). Normally, in the tetrad the chalazal megaspore alone is functional and the micropylar three degenerate (Fig. 5). But, variations in the development of megaspores are frequently met with in the tetrads.

Sometimes, instead of the chalazal megaspore the micropylar one becomes functional and consequently the lower three degenerate (Fig. 6). Sections of some ovules showed two megaspores (i.e., chalazal and micropylar) in

a tetrad developing and the middle two degenerating (Fig. 7). A similar case of more than one megaspore becoming functional in a tetrad has been previously reported in *Tagetes patula*.<sup>3</sup> In a tetrad of another ovule out of the four megaspores the two chalazal and the upper micropylar megaspores showed signs of development while the lower micropylar megaspore was degenerating (Fig. 8). It is interesting to note that these variations may occur in the same capitulum. In one capitulum while one ovule was showing a tetrad with a functional chalazal megaspore, the ovule just by its side was showing a tetrad with two functional megaspores. The above variations



FIGS. 1-13. Fig. 1. L.S. of an ovule showing hypodermal archesporial cell,  $\times 600$ . Figs. 2-3. L.S. of ovule showing megaspore mother cell and dyad respectively,  $\times 600$ . Fig. 4. Linear tetrad of megaspores,  $\times 600$ . Fig. 5. Linear tetrad showing functional chalazal megaspore,  $\times 600$ . Fig. 6. Linear tetrad showing functional micropylar megaspore,  $\times 600$ . Fig. 7. Linear tetrad showing functional chalazal and micropylar megaspores,  $\times 600$ . Fig. 8. Linear tetrad showing the development of three megaspores,  $\times 600$ . Fig. 9. L.S. of ovule showing juxtaposed twin tetrads,  $\times 600$ . Fig. 10. L.S. of ovule showing superposed twin tetrads,  $\times 600$ . Fig. 11. Two-nucleate embryo-sac,  $\times 600$ . Fig. 12. Organised embryo-sac,  $\times 270$ . Fig. 13. L.S. of ovule showing three embryo-sacs,  $\times 270$ .

clearly indicate that, in a tetrad all the megaspores are potentially sporogenetic and the available space and nutrition in the ovule may determine which and how many megaspores become functional.

Further, it is interesting to note that some ovules show twin tetrads which may be juxtaposed or superposed (Figs. 9-10). Both in superposed and juxtaposed twin tetrads the chalazal megaspore only is functional.

The mature embryo-sac is eight-nucleate and of polygonum type (Fig. 12). The cells of the egg apparatus consist of two smooth synergids which are rather elongated and slender with a median egg. The secondary nucleus is close to the egg apparatus. The three antipodals are very big, usually uninucleate and organised as cells. But sometimes, the antipodal cells may be multinucleate. In one case, of the three, antipodal cells, the upper one showed three nuclei, the middle one was uninucleate, while the lower one had four nuclei (Fig. 12). A similar condition of multinucleate antipodals has been reported in *Tagetes patula*.<sup>6</sup>

Exceptionally only one ovule shows three embryo-sacs (Fig. 13). Here, the chalazal one is very small and uninucleate. The middle one has developed upto the two-nucleate stage, while the micropylar embryo-sac occupying three-fourths of the space has developed upto the organised stage. In the organised embryo-sac the egg apparatus is normal with two synergids and a median egg. The cells of the egg apparatus are not as elongated as in the normal embryo-sac and the secondary nucleus abuts the egg cell. In this embryo-sac the three antipodals have remained as nuclei while in the normal embryo-sacs they are organised as cells. It is not known whether they later organise themselves as cells or remain as such. This stage showing three embryo-sacs might be a derivative of the tetrad where three megaspores are developing. In that tetrad (Fig. 8) the chalazal megaspore does not grow as vigorously as the other two developing megaspores. Hence it remains as such. The megaspore immediately above the chalazal one has developed upto two-nucleate stage and the micropylar one has undergone full development. The suppression of development of the two lower embryo-sacs may be due to want of space. Ovules showing more than one embryo-sac have been reported earlier in *Tagetes patula*.<sup>6</sup>

Early in the development of the embryo-sac (i.e., at the two-nucleate stage, Fig. 11) the

nucellus gets crushed and the innermost layer of the integument coming into direct contact with the embryo-sac differentiates itself into integumentary tapetum. The cells of the integumentary tapetum are uninucleate and densely cytoplasmic. The integumentary tapetum almost surrounds the mature embryo-sac.

Fertilisation is porogamous.

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Bangalore-1, March 11, 1968.

1. Davis, G. L., *Phytomorphology*, 1961, **11**, 86.
2. —, *Australian J. Bot.*, 1962, **10**, Pl. 12.
3. — *Ibid.*, 1964, **12**, 142.
4. Schauf, K., *Vergleichende Embryologie der Angiospermen*, 1931.
5. \*Soueffer, R., *C.P. Sci.*, Paris 1920 **171**, 254.
6. Venkateswarulu, J. and Maheswari Devi, H., *Proc. Nat. Inst. Sci.*, 1955, **21 B** (4), 149.

\* Original not seen.

### **ROOTALA ILLECEBROIDES KOEHNE (LYTHRACEAE)—A LITTLE KNOWN FLOWERING PLANT FROM INDIA\***

*Rotala illecebroides* Koehne is an endemic to the Indian subcontinent and was only once recorded previously by Fischer from Annamalai Hills.<sup>1</sup> It is also represented in Wight's collection,<sup>2</sup> but without reference to any locality.<sup>3</sup> The species was first recognised by Arnon on the basis of Wight's collection which was later validated by Koehne.

In the light of the above, the present report of its collection from Hyderabad is significant. Since the plant has been neither fully described nor illustrated in the Indian Floras, it has been felt to fill this gap.

*Rotala illecebroides* Koehne in *Engl. Bot. Jahrb.* 1 : 161 (1881); Gamble, *Fl. Madras*, pl. 3 : 508 (1919).

*Ammannia illecebroides* Arn. ex Koehne, *l.c.* 161 (1881).<sup>3</sup>

*A. pentandra* Roxb. var. *illecebroides* Clarke in *Fl. Brit. Ind.* 2 : 569 (1879), excl. spec. cit.

A small, slender, often branched erect herb, 2-6 cm. high; stems obtusely four-angled. Leaves sessile, opposite-decussate, ovately cordate, 1.5-3 × 3-5 mm. Flowers solitary,

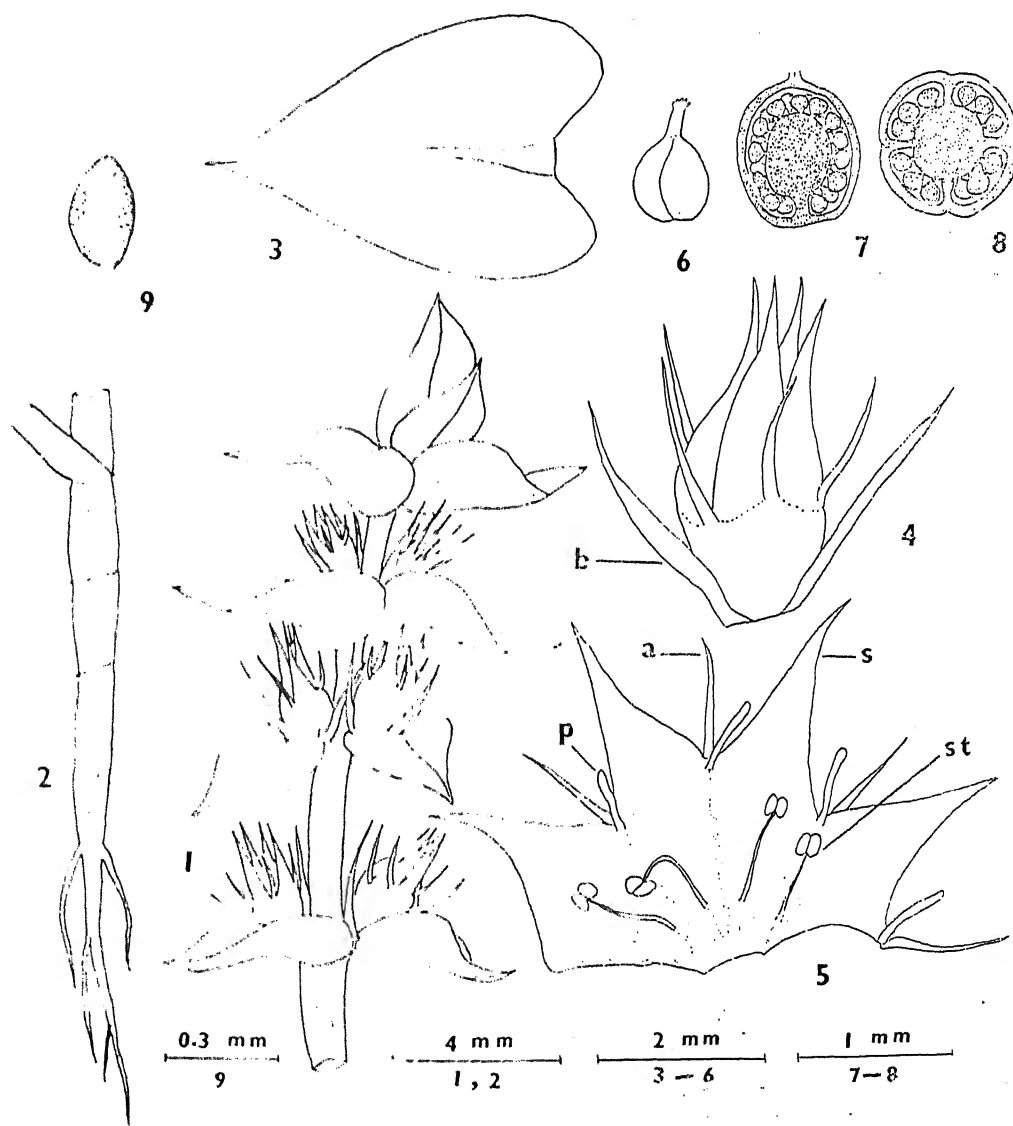


sessile, almost in the axils of every leaf, 2.2-5 mm. long, 1.5 mm. across; bracteoles linear, about 2.5 mm. long. Sepals 4, brick-red, forming a hypanthium; sepal lobes long-acuminate, subulate; appendages, which curve outwards, present at the sinuses between the lobes. Petals 4, dull white, minute, linear. Stamens 4, included, opposite to the sepals, inserted a little above on the base of the hypanthium. Stigma capitate with short style; ovary four-valved. Fruit broadly elliptic to rotund, included within the hypanthium, dehiscing into four valves (rarely 3 due to

one of the chambers being abortive); fruit wall with fine transverse striations, when examined under 25 or above magnification against transmitted light (the striations are due to conspicuously sclerified, transversely elongated inner epidermal cells of the fruit wall). Seeds minute, about 0.3 mm. long, narrowly elliptic flattened on one side, 18-30 in each fruit.

Growing along with *Drosera burmanni* Vahl, *D. indica* L., *Utricularia* species, grasses and sedges on sandy soil of dripping rocks.

Flowering and fruiting: November-January.



FIGS. 1-9. *Rotala illecebroides*. Fig. 1. A branch with flowers and leaves. Fig. 2. Lower part of the plant showing the roots. Fig. 3. Leaf. Fig. 4. Flower with bracteoles (b). Fig. 5. Cut-open flower showing sepals (s), appendages (a), petals (p), stamens (st). Fig. 6. Gynoecium. Fig. 7. L.S. ovary. Fig. 8. T.S. ovary. Fig. 9. Seed.

Hyderabad (Thummala Kunta): Rajagopal 578 (deposited at the Osmania University, Botany Department, Herbarium = HY).

It is pertinent to remark that the plant was previously collected from about 1200 m. altitude, Annamalai Hills which is about 800 km. away from Hyderabad, a place which is 400 m. above sea-level. From the difference in the distance as well as the altitude of the two places it is obvious that the species may have a wider distribution than presently known. Very probably, the small size and entanglement with other ground elements, particularly the grasses and sedges, were responsible for its non-observance from a wider area.

Our gratitude is due to Prof. M. R. Suxena for facilities and encouragement. Our thanks are also due to Andhra Pradesh Academy of Sciences for financing the project and to the Council of Scientific and Industrial Research, New Delhi, for the award of a Senior Research Fellowship to one of us (T. R.).

Department of Botany, T. RAJAGOPAL,  
University College of N. RAMAYYA,  
Science, Osmania University,  
Hyderabad-7 (A.P.), March 21, 1968.

\*Contribution No. 4 under Flora of Hyderabad Scheme.

1. Gamble, J. S., *Flora of the Presidency of Madras*, London, 1919, Pt. 3, p. 508.
2. Clarke, C. B., In Hooker's *Fl. Brit. Ind.*, London 1879, 2, 569.
3. *Index Kewensis*, Vols. 1 & 2, London, 1893.

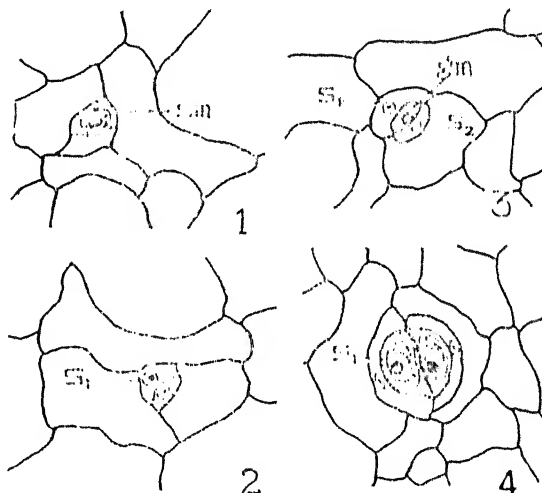
#### DEVELOPMENT OF STOMATA IN PHASEOLUS

FROM the available literature it is revealed that Metcalfe and Chalk<sup>1</sup> are the only persons to describe the occurrence of Rubiaceae type of stomata in *Phaseolae*. Because the ontogeny of stomata is not mentioned, the present authors made a critical study on the development of stomata in *Phaseolus aureus*, *P. mango* and *P. trilobus*. Young leaves of all the three species were separately boiled in 2%  $\text{HNO}_3$  solution for 2 minutes. When cooled, the epidermal layer from leaves came out as peels. These were washed properly and stained in acetocarmine and mounted in glycerine.

Since the development of stomata in all the 3 species is same, the figures and descriptions are referred to *P. aureus* only.

The stomatal meristemoids are easily distinguishable from other cells due to their small size, almost triangle-shaped and densely filled cytoplasm. This meristemoid cell divides longitudinally by means of a curved wall

delimiting a comparatively large cell and a small lenticular cell (Fig. 2) which again divides into two equal halves due to formation of a curved wall almost parallel to the previous one (Fig. 3). Thus a tier of 3 cells is produced, one central and two-flanked cells that elongate parallel to the longitudinal axis of the central cell and function as subsidiary cells. The central cell after slight elongation undergoes a longitudinal division producing two guard cells of similar size (Fig. 4). The development of stomata thus conforms to the Rubiaceae (or Paracytic) type and because the subsidiary cells and guard cells are produced from the same meristemoid, the development of such paracytic stomata conforms to the mesogenous type of Pant.<sup>2</sup> The



FIGS 1-4. Development of stomata,  $\times 732$  (gm guard mother cell;  $S_1$  &  $S_2$ , subsidiary cells; sm, stomatal meristemoid). Fig. 1. A stomatal meristemoid. Fig. 2. One of the subsidiary cells ( $S_1$ ) being cut off. Fig. 3. Subsidiary cells ( $S_1$ ,  $S_2$ ) and the central guard mother cell (gm). Fig. 4. Fully developed stomata.

present observation therefore conforms totally to that of Metcalfe and Chalk in describing the stomata type in *Phaseolus*. It is interesting to find that in many stomata the epidermal cells of the leaves assume the shape of the subsidiary cells, lying juxtaposed with the latter. They are distinguished from the actual subsidiary cells by means of their large size.

Pulse Research Station,  
Nayagarh (Orissa),  
March 26, 1968.

R. C. MISRA.  
R. C. SAHU.  
B. SAHU.

1. Metcalfe, C. R. and Chalk, L., *Anatomy of the Dicotyledons*, Clarendon Press, Oxford, 1957.
2. Pant, D. D., *Pl. Sci. Ser.*, 1965, 1, 1.

## REVIEWS AND NOTICES OF BOOKS

**Solvent Properties of Surfactant Solutions** (Vol. 2). Edited by Kozo Shinoda. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1967. Pp. ix + 365. Price \$18.50.

In this second volume of the Surfactant Science Series, the basic characteristics and applications of the solvent properties of surfactant solutions are discussed in detail by outstanding international authorities, experts in their respective areas of surfactant science.

The contents of this volume are: (1) An Outline of the Solvent Properties of Surfactant Solutions; (2) Solvent Properties of Non-ionic Surfactants in Aqueous Solutions; (3) The Interactions of Polar Molecules, Micelles, and Polymers in Nonaqueous Media; (4) Physical Chemistry of Cleansing Action; (5) Pharmaceutical Applications and Physiological Aspects of Solubilization; (6) Surfactants in Pesticidal Formulations; (7) Emulsion Polymerization.

This book will be found useful by basic surfactant scientists, as well as those engaged in the applications of surfactants, such as surfactant manufacturers, pharmacists, and polymer and agricultural chemists. C. V. R.

**Annual Review of Entomology** (Vol. 13). Edited by Ray F. Smith and Thomas E. Mittler. (Annual Reviews, Inc., 4139 El Camino Way, Palo Alto, California), 1968. Pp. 488. Price \$9.00.

In this volume of the Review, three chapters are presented on topics now being given emphasis by the Working Group in Biological Control of the International Biological Program. The Editorial Committee felt that both its general readership and the I.B.P. would be well served by the inclusion of these chapters, since the subjects cover aspects that are strictly of biological control, as well as the fundamental ecology of some of the most important agricultural insect pests in the world. It is planned for Volume 14 of this series that other I.B.P.-related chapters will be published, as well.

Volume 13 contains the following articles:  
Endocrine Control of Reproduction in Insects;

The Role of the Nervous System in Insect Morphogenesis and Regeneration; The Connective Tissues of Insects; Insecticide-Cytoplasmic Interactions in Insects and Vertebrates; Biochemistry and Taxonomy; Chemosensory Bases of Host Plant Selection; The Allergic Responses to Insect Bites; Neoplasms of Insects; Honey Bee Pathology; Pesticide Usage in Relation to Bee-keeping; Bionomics of Siricidae; Ecology of Common Insect Pests of Rice; Impact of Parasites, Predators, and Diseases on Rice Pests; Impact of Pathogens, Parasites and Predators on Aphids; Intrafloral Ecology; The Population Genetics of Insect Introduction; Age Structure of Insect Populations of Medical Importance. C. V. R.

**Tobacco and Tobacco Smoke**. Edited by Wynder and Hoffmann. (Academic Press, New York and London), 1968. Pp. xiii + 730. Price \$29.00.

This book presents a discussion of the biological and chemical aspects of tobacco and tobacco smoke carcinogenesis and related fields. Major recent studies and laboratory methods practised in tobacco carcinogenesis and their chemical-analytical foundation are provided.

The book contains, in a concise, tabular form, a selective summary of experiments on the biological testing of tobacco extracts, tobacco smoke and smoke condensate, and fractions of these materials. Groups of tobacco constituents are also tabulated, with an evaluation of their respective roles in experimental carcinogenesis.

A major topic is the possibility of reducing carcinogenic and/or co-carcinogenic properties of tobacco products. Discussed also are such fields as tobacco production and processing, reconstituted tobacco sheet, filtration of cigarette smoke, and the selective filtration of tobacco smoke.

The book is intended to provide a guide as well as a stimulus to those beginning or continuing work in any of the many phases connected with the subject. C. V. R.

**The Planning of Milk Production in India.** By R. O. Whyte and M. L. Mathur. (Orient Longmans Limited, 36, Mount Road, Madras-2), 1968. Pp. 221. Price Rs. 10-00.

In human nutrition milk occupies a predominantly important place. The question of its economic production is a matter of great concern, especially in urban areas where population grows *pari passu* the growth of industry and commerce. A dairy project in such an area is beset with various problems connected with the project. The authors of this book, who have made on-the-spot studies and collected all relevant data, have evolved a technique which may be used in the planning of all aspects of milk production in India. It will be equally useful to other tropical countries faced with similar problems. Mr. Whyte is FAO Grassland and Fodder Adviser in India, and Mr. Mathur is connected with the National Dairy Research Institute of the Indian Council of Agricultural Research. A. S. G.

**Real Analysis: An Introduction.** By A. J. White. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W. 1, England), 1967. Pp. 244. Price 38 sh. (paper); 55 sh. (hard).

This text is intended to introduce students to the methods of modern analysis. Axiomatic discussions, topological ideas and metric spaces are introduced even at the outset. The subject-matter is covered in the following chapters: Notation and Terminology; The Real Number System; Metric Spaces; Real Functions; Differential Calculus; Riemann Integral; Infinite Series and Power Series; Differential Equations. Exercises and problems are included in each chapter. A. S. G.

#### Books Received

**Raman and Infrared Spectroscopy.** Edited by K. Venkateswarlu. (University of Kerala, Ernakulam Centre, Ernakulam), 1968. Pp. vi + 258. Price not given.

**Theory and Applications of Holography.** By J. B. Develis and G. O. Reynolds. (Addison-Wesley Publishing Co., Reading, Massachusetts), 1967. Pp. xi + 196. Price \$ 12.95.

**Elementary Calculus.** By G. Hadley. (Holden Day, Inc., 500, Sansome Street, San Francisco), 1968. Pp. ix + 421. Price \$ 10-75.

**Engineering Mechanics (Vol. 2).** By T. C. Huang. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W. 1, England), 1967. Pp. xv + 398-860. Price \$ 7.95.

#### ANNOUNCEMENTS

**Lady Tata Memorial Trust Scholarships and Grants for the Year 1968-69**

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Meherbai Dorabji Tata, 18th June 1968, the awards of scholarships and grants for the year 1968-69.

International Awards of varying amounts (totalling £ 7,360/-) for research in diseases of the blood with special reference to Leukemias are made to:

1. Dr. V. Balazs (Holland); 2. Dr. M. Frohlich (Holland); 3. Dr. R. Hancock (Switzerland); 4. Dr. D. Viza (France); 5. Dr. (Mrs.) E. Davidson (Great Britain); 6. Dr. (Miss) A. M. Tomkys (Great Britain); 7. Dr. P. Stryckmans (Belgium).

Indian Scholarships of Rs. 300 per month each for one year for scientific investigations having a bearing on the alleviation of human suffering from disease are awarded to:

1. Dr. (Miss) Usha C. Parekh (Bombay); 2. Mr. C. Dwivedi (Gorakhpur); 3. Dr. M. K. Jain (Bombay); 4. Miss K. N. Rangnekar (Bombay); 5. Miss Chameli Ganguly (Calcutta); 6. Mr. Santosh K. Kar (Kanpur); 7. Dr. N. H. Tolia (Bombay); 8. Miss Kakoli Bose (Calcutta).

#### ERRATA

*Current Science*, June 5, 1968, pp. 301-304

1. On p. 301, Para 1, line 2, *acae* should be *acae*.
2. On p. 301, Para 4, line 4,  $[a]$  should be  $[a]_n$ .
3. On p. 301, Para 4, line 9, 200 should be 2-00.
4. On p. 301, Para 6, line 6, underpressed should be underdepressed.
5. On p. 302, Para 1, line 1,  $\nu_{\max}$  cm.<sup>-1</sup> should be  $\nu_{\max}$  1735 cm.<sup>-1</sup>
6. On p. 302, Para 2, line 19, CH OH should be CHOH.
7. On p. 303, Para 5, first line should be deleted and replaced by "IR spectra of both acid and ester show the."

# ANGULAR DISTRIBUTION OF THE NEUTRONS FROM $\text{Li}^7$ (d.n.) $\text{Be}^8$ REACTION AND THE ENERGY LEVELS IN $\text{Be}^8$

M. K. SAXENA\* AND J. P. SAH

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## INTRODUCTION

THE neutrons produced on bombardment of lithium with deuterons have been studied by a large number of workers and, as in the case of other reactions leading to the same final nucleus, contradictory conclusions have been reached regarding the number of levels observed in  $\text{Be}^8$ . Some investigators<sup>1-6</sup> have reported besides the ground state, only one other level corresponding to about 3 MeV below the excitation levels of 10 MeV; others<sup>7-9</sup> have produced evidence for additional energy levels of  $\text{Be}^8$  corresponding to excitation energies of 1.5, 2.1, 4.1, 5.4 and 7.5 MeV. However, no systematic study has been made of the angular distribution of the outgoing neutrons from the (Li,d) reaction. In view of this a further investigation of the above reaction seems desirable. The angular distribution of the neutrons would throw light on the mechanism of the reaction.

In the present work an 86 KeV thick target of ordinary lithium was bombarded with 500 KeV deuterons from the Cockcroft-Walton generator of the Tata Institute of Fundamental Research, Bombay.

Ilford G5 Nuclear Research plates ( $7.62 \times 2.54$  cm.) with thickness of  $400 \mu$  were exposed to the emitted neutrons. The plates were held radially at a distance of 16.2 cm. from the target so as to receive neutrons proceeding at angles of  $0^\circ$ ,  $45^\circ$ ,  $60^\circ$ ,  $90^\circ$ ,  $120^\circ$ ,  $135^\circ$  and  $150^\circ$  to the direction of the deuteron beam. After irradiation the plates were processed using the method of 'temperature development' suggested by Dilworth *et al.*<sup>10</sup>

The plates were examined on a Cooke, Troughton and Simms nuclear research microscope and the modified procedure used in our earlier work (Sah<sup>11</sup> and Saxena and Sah<sup>12</sup>) was followed. At each angle 750 tracks were measured. The criteria, set for accepting tracks, reduced the number of tracks running out of the plate. Only 6, 5, 6, 5, 6, 2 and 2 tracks ran out of the emulsion at angles of

$0^\circ$ ,  $45^\circ$ ,  $60^\circ$ ,  $90^\circ$ ,  $120^\circ$ ,  $135^\circ$  and  $150^\circ$  respectively. These numbers being too small as compared to the number of tracks recorded, no correction was needed for loss of tracks from the plate. In all previous investigations a correction had to be applied for such tracks; the correction being approximate, the absolute yield of the reaction could not be estimated.

## THE NEUTRON ENERGY SPECTRUM

The energy corresponding to the measured ranges of the recoil protons was obtained from the range energy relations given by Wilkins.<sup>13</sup> The data for each angle were collected in the form of a histogram where the number of tracks were plotted against the neutron energy, using intervals of 0.1 MeV. For obtaining the real energy spectrum correction had to be made for the variation of the neutron-proton scattering cross-section  $\sigma$ . While ascertaining each recoil angle the change in the direction of the neutron incident on the plate with difference in position of the point of origin of the recoil proton track in the emulsion, has been taken into consideration. Correction has also been made for thickness of the target while calculating the Q-values.

The information regarding the energy levels of  $\text{Be}^8$  has been obtained from a study of the individual Q-spectra at the various angles. Two such spectra for angles of  $60^\circ$  and  $90^\circ$  are shown in Figs. 1 and 2. Out of the large number of peaks observed some will arise due to statistical fluctuations. Only those peaks have been regarded as genuine which occur at all the seven angles at precisely the same Q-value. These will correspond to the formation of  $\text{Be}^8$  at different excitation levels. It seems extremely unlikely that statistical fluctuations will give rise to homogeneous groups of particles at all the angles with exactly the same disintegration energy.

The data have been shown in Table I. Evidence has been produced for levels in  $\text{Be}^8$  at excitations of 2.1, 2.8, 3.5, 4.1, 4.88, 5.96, 6.55 and 7.57 MeV besides the ground state. Information regarding levels with higher excitation cannot be obtained due to the presence of  $\text{Li}^6$  in the target.

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THE ANGULAR DISTRIBUTION OF THE NEUTRONS  
From the proton track densities found in the  
different plates the angular distribution of the

neutrons was obtained. The neutron yield  
corresponding to the formation of  $\text{Be}^8$  in the  
ground state has been calculated in terms of

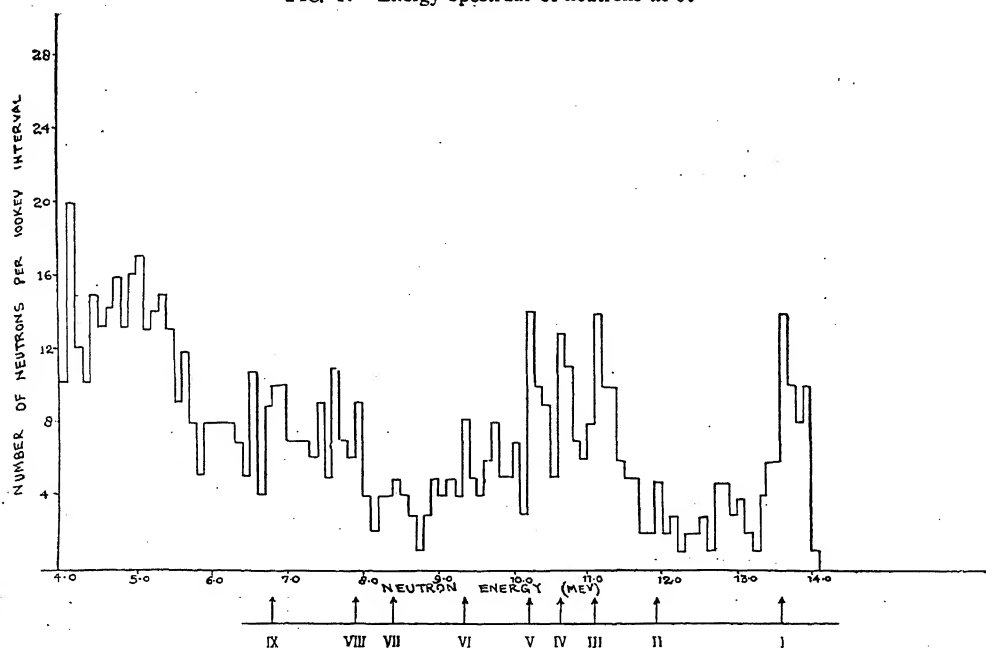
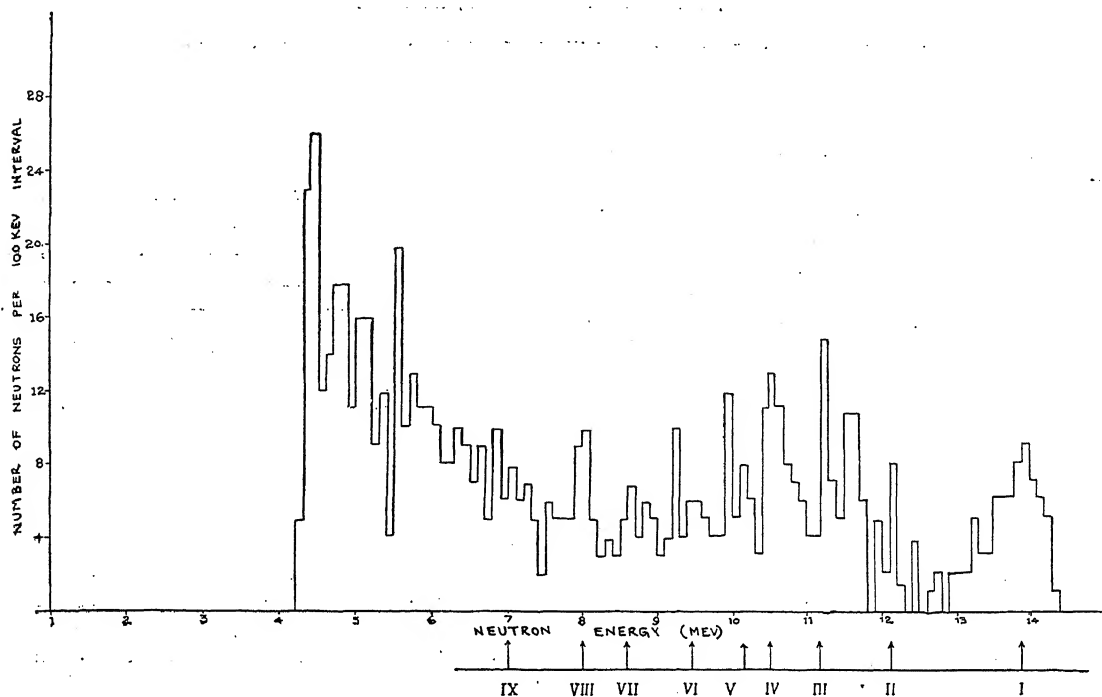


TABLE I

Excitation energy  $E_x$  in MeV for the energy levels of  $\text{Be}^8$  at different angles with respect to the deuteron beam

$E_x$ in MeV Angles	0	2.1	2.8	3.5	4.1	4.88	5.96	6.55	7.57
0°	G.S.	2.19 ±0.1	2.73 ±0.2	3.33 ±0.17	4.04 ±0.16	4.86 ±.17	6.00 ±.16	6.43 ±.17	7.52 ±.18
45°	"	2.14 ±.12	2.65 ±.21	3.42 ±.15	4.08 ±.18	4.85 ±.16	6.07 ±.18	6.71 ±.18	7.59 ±.15
60°	"	2.10 ±.15	2.89 ±.14	3.60 ±.18	4.21 ±.16	4.93 ±.18	5.87 ±.15	6.53 ±.13	7.64 ±.16
90°	"	2.01 ±.1	2.82 ±.14	3.38 ±.19	3.88 ±.18	4.84 ±.17	5.85 ±.18	6.42 ±.15	7.60 ±.12
120°	"	2.29 ±.2	2.98 ±.2	3.54 ±.18	4.06 ±.17	4.93 ±.14	6.01 ±.17	6.52 ±.16	7.56 ±.12
135°	"	2.24 ±.11	2.99 ±.2	3.68 ±.18	4.14 ±.16	4.84 ±.15	5.99 ±.13	6.57 ±.14	7.62 ±.13
150°	"	2.14 ±.11	2.83 ±.14	3.35 ±.21	4.20 ±.15	4.92 ±.14	5.85 ±.13	6.66 ±.15	7.18 ±.10

the number of tracks per  $10^9 \mu^2$  (This has been normalised to 1.0 for  $\theta = 0^\circ$ ). The angular distribution was transferred to the centre of mass system using the formula of Haxby *et al.*<sup>14</sup> The angles of emission of the neutrons and the yields in the C-co-ordinates are shown in columns two and four respectively of Table II, while the normalized yield is given in the last column.

TABLE II

Yield of the reaction  $\text{Li}^7 (d, n) \text{Be}^8$  at the different angles

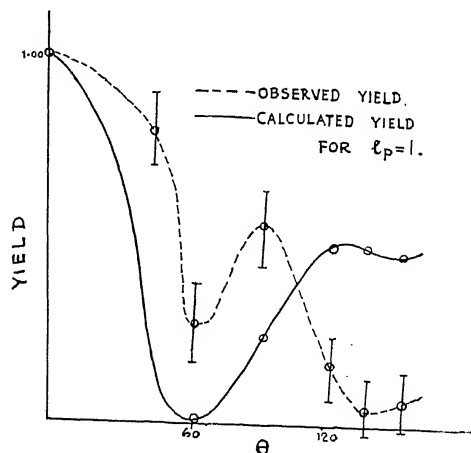
Angles in L-Co-ordinates	Angles in C-Co-ordinates	Yield in L-Co-ordinates	Yield in C-Co-ordinates	Normalised yield
0°	0	3.756	3.756	1.000
45°	46° 13'	3.361	3.223	0.856 ± 0.07
60°	61° 29'	1.967	1.910	0.508 ± 0.06
90°	91° 43'	2.614	2.614	0.695 ± 0.07
120°	121° 29'	1.645	1.668	0.443 ± 0.06
135°	136° 13'	1.304	1.333	0.355 ± 0.06
150°	150° 52'	1.418	1.451	0.385 ± 0.05

The yield shows a pronounced forward maximum indicating that the formation of  $\text{Be}^8$  is mainly through the stripping process.

No theory for the angular distribution of the neutrons from  $d-n$  reactions has so far been worked out for low deuteron energies. For higher energies the coulomb barrier has been

neglected and a theory of the stripping process has been given by Butler.<sup>15</sup> This theory has also been applied to low deuteron energies, but in this case the compound nucleus mechanism also makes an appreciable contribution to the angular distribution.

The observed data have been subjected to further analysis by applying Butler's theory. The differential cross-sections have been obtained at various angles for  $l_p = 0, 1$  and  $2$  denoting the angular momentum transferred by the captured proton. The values for  $l_p = 1$  show the closest fit with the observed data as shown in Fig. 3. There is agreement as far

FIG. 3. Angular distribution in the centre-of-mass system of the reaction  $\text{Li}^7 (d, n) \text{Be}^8$ .

as the general nature of the curves is concerned namely in respect of the pronounced forward maximum, then a minimum at an angle of about  $60^\circ$  followed by a second maximum. There is however a considerable deviation in the observed and calculated yields in the backward direction. This may however be expected on account of Butler's theory being approximate at the small deuteron energy used in the present work.

It can therefore be concluded that the target nucleus  $\text{Li}^7$  accepts a proton of orbital angular momentum  $l_p = 1$  directly into the ground state of  $\text{Be}^8$ . This value of  $l_p$  is consistent with the change of parity in the  $\text{Li}^7(d,n)\text{Be}^8$  reaction. It also implies that the ground state of  $\text{Be}^8$  has spin 0 or 2, the odd values being not permitted on account of observed break up of  $\text{Be}^8$  into two  $\alpha$ -particles (Crussard<sup>16</sup> and Jones *et al.*<sup>17</sup>).

#### CONCLUSION

In the present investigation evidence has been found for the levels in  $\text{Be}^8$  at 2.1, 2.8, 3.5, 4.1, 4.88, 5.96, 6.55 and 7.57 MeV. excitation besides the ground state. This is at variance with the results of most of the workers and is in agreement with the findings of Trumpy *et al.*<sup>7</sup> and Catala *et al.*<sup>8</sup>

The results obtained in the present experiment are more conclusive than that of Catala *et al.* as the latter studied the reaction at only two angles. In the work of both Trumpy *et al.* and Catala *et al.* a correction, which is approximate, had to be applied for the tracks running out of the plate. Due to the modified procedure of scanning and measurement followed in the present work no correction was needed for escape of tracks; it also avoided the determination of the shrinkage factor of the emulsion, whose value is ascertained approximately in the other investigations.

The angular distribution of the neutrons shows that the formation of  $\text{Be}^8$  in the ground state is predominantly due to the stripping process. Analysis of data indicates this state of  $\text{Be}^8$  to be  $0^+$  or  $2^+$ . The problem

regarding the relative importance of the stripping process and the compound nucleus formation can only be solved by a new theory for the stripping process at low deuteron energies.

The authors' thanks are due to Prof. B. G. Gokhale for his kind interest and helpful suggestions and to Dr. R. Ramanna for making available to us the facilities at the Tata Institute of Fundamental Research, Bombay, for the exposure and processing of the nuclear emulsions. The authors wish to express their indebtedness to the Council of Scientific and Industrial Research, New Delhi, for awarding a Research Fellowship to one of us (M. K. S.).

1. Spears, R. H., *Aust. J. Phys.*, 1958, **11**, 502
2. Titterton, E. W., Gamuelli, D. S. and Morton, A. H., *Nucl. Phys.*, 1959, **10**, 33.
3. Juna, J., Horwath, P. and Konecny, K., *Czech. J. Phys.*, 1960, **10**, 715.
4. Cerney, J., Harvey, R. G. and Puel, R. H., *Nucl. Phys.*, 1962, **29**, 120.
5. Purser, K. H. and Wildenthal, B. H., *Ibid.*, 1963, **44**, 22.
6. Browne, C. B. and Dorenbusch, W. E., *Phys. Rev.*, 1963, **131**, 1212.
7. Trumpy, B., Grottdal, T. and Graue, A., *University of Bergen Yearbook No. 8*, University of Bergen, Bergen, Norway, 1963.
8. Catala, J., Aguilar, J. and Busquets, E., *An. Real. Soc. Espan. Fis. Quim.*, 1963, **49 A**, 131.
9. Vlasov, N. A., Kalinin, S. P., Oplodkin, A. A. and Chnev, V. I., *Zh. eksperiment.*, USSR, 1960, **39**, 1468.
10. Dilworth, C. C., Occhialini, G. P. S. and Payne, R. M., *Nature*, London, 1948, **163**, 102.
11. Sah, J. P., *Ind. J. Phys.*, 1965, **39**, 193.
12. Saxena, M. K. and Sah, J. P., *Ibid. J. Pure Appl. Phys.*, 1964, **2**, 364.
13. Wilkins, J. J., *Atomic Energy Research Establishment Report G/R 664*, 11M Stationary Office, London, 1961.
14. Haxby, Allen and Williams, *Phys. Rev.*, 1939, **55**, 142.
15. Butler, S. T., *Proc. Roy. Soc.*, 1951, **208 A**, 559.
16. Crussard, J., *Nature*, 1950, **166**, 825.
17. Jones, Donahue, McEllistrem, Douglas and Richards, *Phys. Rev.*, 1953, **91**, 879.



## DISTRIBUTION OF $\alpha$ - AND $\beta$ -ISOMERS OF N-OXALYL- $\alpha$ , $\beta$ -DIAMINO PROPIONIC ACID IN SOME INDIAN VARIETIES OF *L. SATIVUS*

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**N**EUROLATHYRISM, a crippling disease associated with the consumption of *L. sativus* for a prolonged period, is endemic in several villages in Central India where the consumption of the pulse is generally high.<sup>1</sup> A toxic principle, capable of inducing neurological symptoms in young chicks through injections of aqueous ethanol extract of *L. sativus* was identified by Roy, Nagarajan and Gopalan,<sup>2</sup> and later isolated and characterised by Adiga, Rao and Sarma<sup>3</sup> as an unusual amino-acid,  $\beta$ -(N)-oxalyl- $\alpha$ ,  $\beta$ -diamino propionic acid or  $\beta$ -(N)-oxalyl amino alanine. The compound was found to be neurotoxic to other species of animals like rat<sup>4</sup> and duckling.<sup>5</sup> Injected intrathecally into monkeys, it could induce paraplegia.<sup>6</sup>

Analysis of a large number of samples of *L. sativus* collected from the endemic area indicated that the concentration of total (N)-oxalyl- $\alpha$ ,  $\beta$ -diamino propionic acid (BOAA) in them varied widely, ranging from 0.1 to 2.5%.<sup>7</sup> Bell and O'Donovan<sup>8</sup> showed that the naturally occurring (N)-oxalyl- $\alpha$ ,  $\beta$ -diamino propionic acid can exist in two forms as  $\alpha$ - and  $\beta$ -isomers, which could be separated by high voltage electrophoresis. A reversible transfer of the oxalyl group between  $\alpha$ - and  $\beta$ -amino groups could occur with the establishment of an equilibrium under certain experimental conditions. Under normal conditions, the concentration of the  $\beta$ -form was about 95% of the total compound present in the seeds. It is, however, not established whether the two isomers of the above compound are equally effective as neurotoxic agents.

In the present study, the distribution of  $\alpha$ - and  $\beta$ -oxalyl derivatives of diamino propionic acid in some Indian varieties of *L. sativus* seeds, containing high and low concentrations of this compound, was investigated. Since the concentration of the oxalyl derivatives of diamino propionic acid increases during germination of the seeds, the distribution of  $\alpha$ - and  $\beta$ -isomers was also estimated in the germinating seeds.

Twelve selected samples of *L. sativus* collected from different districts of Madhya Pradesh were divided into two main groups: (a) six samples of low BOAA-containing varieties in which the BOAA concentration ranged from 0.12 to 0.25%; and (b) six samples with high BOAA content ranging from 2.00 to 2.25% of the toxin.

Two-and-a-half grams of seeds were used for analysis as such, and another identical batch was allowed to germinate under optimum laboratory conditions before being taken up for analysis. A 30% alcohol extract of the seeds prepared according to the procedure of Nagarajan *et al.*<sup>9</sup> was lyophilised at 0.05 mm. and  $-60^{\circ}\text{F}$ ., to complete dryness. This procedure eliminated any possibility of interconversion of  $\alpha$ - and  $\beta$ -isomers of the oxalyl derivative of diamino propionic acid.

The lyophilised material was dissolved in a known volume of distilled water and subjected to electrophoresis in Beckman Model R paper electrophoresis system with "Durrum" type cell. Ten to twenty  $\mu\text{l}$  of the extract was applied on Whatman No. 1 filter-paper strip and the fractionation was carried out in a buffer system containing formic acid, pyridine and water (4.0 : 0.3 : 95.7) at pH 2.2 and 300 V for 4 hours. The relatively fast moving  $\beta$ -isomer and the slow moving  $\alpha$ -isomer were identified by staining with ninhydrin and scanned in Beckman "Analytrol" densitometer. Isolated and purified oxalyl derivative of  $\alpha$ ,  $\beta$ -diamino propionic acid<sup>9</sup> when subjected to electrophoresis under the above conditions also showed two distinct spots corresponding to the above two positions and these two could be distinguished by their colour development with ninhydrin.<sup>8</sup> To obtain the relative concentration of each isomer, the area under the corresponding peak was calculated as percentage of the total area.

It was observed (Table I) that irrespective of the concentration of BOAA in different varieties of *L. sativus*, the proportion of  $\alpha$ - and  $\beta$ -isomers of the compound remained

TABLE I

Percentage of  $\alpha$ - and  $\beta$ - forms of BOAA in low and high BOAA containing *L. sativus* seeds and corresponding seedlings

Sample No.*	% BOAA*	In seeds $\beta$ form as % of total	In seedlings $\beta$ form as % of total
I. BOAA Low Variety			
247	0.20	95.0	96.1
2	0.12	89.7	96.3
10	0.25	94.3	95.8
32	0.25	93.0	93.6
24	0.25	90.4	97.0
13	0.12	90.0	94.7
Average	0.19	92.06	95.6
$\beta$ -isomer =	92.06%	$\beta$ -isomer =	95.6%
$\alpha$ -isomer =	7.94%	$\alpha$ -isomer =	4.4%
II. BOAA High Variety			
S-38	2.25	93.8	95.5
S-90	2.13	97.3	94.4
S-13	2.13	95.2	94.3
S-83	2.13	96.1	97.8
S-102	2.00	97.7	98.5
BGT-200	2.00	95.7	97.1
Average	2.10	95.9	96.2
$\beta$ -isomer =	95.9%	$\beta$ -isomer =	96.2%
$\alpha$ -isomer =	4.1%	$\alpha$ -isomer =	3.8%

\* Samples and analytical data were kindly supplied by Dr. V. Nagarajan.

constant. The  $\beta$ -isomer in "high" and "low" BOAA-containing varieties of *L. sativus* ranged between 92 and 96% of the total BOAA, while  $\alpha$ -isomer was very low (4.8%) in the samples studied. The process of germination did not alter the relative proportions of  $\alpha$ - and  $\beta$ -isomers.

Thanks are due to Dr. C. Gopalan, Director of these Laboratories, for his constant interest in this investigation, and to Dr. P. G. Tulpule for critically going through the manuscript.

1. Ganapathy, K. T. and Dwivedi, M. P., *Studies on Clinical Epidemiology of Lathyrism*, 1961.
2. Roy, D. N., Nagarajan, V. and Gopalan, C., *Curr. Sci.*, 1963, **32**, 116.
3. Adiga, P. R., Rao, S. L. N. and Sarma, P. S., *Ind. J.*, 1963, **32**, 153.
4. Rao, S. L. N. and Sarma, P. S., *Biochem. Pharmacology*, 1967, **16**, 218.
5. Nagarajan, V., Mohan, V. S. and Gopalan, C., *Ind. Jour. Med. Res.*, 1965, **53**, 269.
6. Rao, S. L. N., Sarma, P. S., Mani, K. S., Raghunatha Rao, T. R. and Sriramachari, S., *Nature*, 1967, **214**, 610.
7. Nagarajan, V. and Gopalan, C., *Ind. Jour. Med. Res.*, 1968, **56**, 95.
8. Bell, E. A. and O'Donovan, J. P., *Phytochemistry*, 1966, **5**, 1211.
9. Nagarajan, V., Roy, D. N., Mohan, V. S. and Gopalan, C., *Annual Report, Nutrition Research Laboratories, Hyderabad*, 1963 p. 39.

## ON THE FLOW OF A CONDUCTING FLUID IN A ROTATING STRAIGHT PIPE

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CONSIDER a weakly conducting fluid flowing through a straight pipe, walls  $z = \pm L$ , under the action of a constant pressure gradient  $-\partial\Pi/\partial x$  in the direction of  $x$ -axis.  $H_0$  is a uniform magnetic field imposed along  $z$ -axis and the walls rotate with an angular velocity  $\Omega$  about the same axis. Assuming that the motion is laminar, the equations of hydromagnetic motion<sup>1</sup> in a rotating frame of reference (stationary relative to the walls) for an incompressible fluid in terms of the complex velocity field  $q(z, t) = u + i v$  is

$$\frac{\partial q}{\partial t} + 2i\Omega q = -\frac{1}{\rho} \frac{\partial H}{\partial x} + \nu \frac{\partial^2 q}{\partial z^2} - m q, \quad (1)$$

where

$$\Pi = p - \frac{1}{2} \rho \Omega^2 (x^2 + y^2), \quad m = \frac{\sigma \mu^2 H_0^2}{\rho}. \quad (2)$$

We assume at  $t=0$ ,  $q=0$ . The motion is caused by sudden change of pressure gradient

from zero to a constant quantity  $P$  at  $t=0$ . We represent

$$\frac{1}{\rho} \frac{\partial H}{\partial x} = P H(t) \quad \text{at } t=0, \quad (3)$$

where  $H$  is a Heaviside's unit function.

We seek the solution of (1) subject to the conditions for no slip at the walls,

$$q=0 \quad \text{for } t=0 \quad \text{at } z=\pm L. \quad (4)$$

Using the Laplace transform technique, we find that the solution  $\tilde{q}$  of the transformed differential equation satisfies,

$$\tilde{q} = \frac{Pch \sqrt{s^2 + m + 2i\Omega}}{s(s^2 + m + 2i\Omega)} \exp\left(\frac{s^2 + m + 2i\Omega}{\nu} z\right) + \frac{P}{s(s^2 + m + 2i\Omega)}. \quad (5)$$

On inversion and separating real and imaginary parts, we get

$$u = u_{st} + \sum_{j=1,3,\dots}^{\infty} \frac{16PL^3}{j\pi r} \exp. \left\{ \left( \frac{\pi^2 j^2 \nu}{4L^2} + m \right) t \right\} (-1)^{(j+1)/2} \cos(2\Omega t + \theta) \cos \frac{\pi j z}{2L}, \quad (6)$$

$$v = v_{st} + \sum_{j=1,3,\dots}^{\infty} \frac{16PL^3}{j\pi r} \exp. \left\{ \left( \frac{\pi^2 j^2 \nu}{4L^2} + m \right) t \right\} (-1)^{(j-1)/2} \sin(2\Omega t + \theta) \cos \frac{\pi j z}{2L}, \quad (7)$$

where

$$u_{st} = \frac{Pm}{m^2 + 4\Omega^2} P \frac{\{chaL \cos \beta L (mchaz \cos \beta z + 2\Omega shaz \sin \beta z) + shal \sin \beta L (mshaz \sin \beta z - 2\Omega chaz \cos \beta z)\}}{(m^2 + 4\Omega^2) (ch^2 aL \cos^2 \beta L + sh^2 aL \sin^2 \beta L)}, \quad (8)$$

$$v_{st} = \frac{2P\Omega}{m^2 + 4\Omega^2} P \frac{\{chaL \cos \beta L (mshaz \sin \beta z - 2\Omega chaz \cos \beta z) + shal \sin \beta L (mchaz \cos \beta z + 2\Omega shaz \sin \beta z)\}}{(m^2 + 4\Omega^2) (ch^2 aL \cos^2 \beta L + sh^2 aL \sin^2 \beta L)}, \quad (9)$$

$$r = \frac{1}{\sqrt{(\pi^2 j^2 \nu + 4L^2 m)^2 + 64L^4 \Omega^2}}, \quad \tan \theta = \frac{8L^2 \Omega}{(\pi^2 j^2 \nu + 4L^2 m)}, \quad \alpha + i\beta = \sqrt{\frac{(m + 2i\Omega)}{\nu}} \quad (10)$$

For small  $t$ , we obtain from (5)

$$u = \frac{P}{m^2 + 4\Omega^2} [m(1 - e^{-mt} \cos 2\Omega t) + 2\Omega e^{-mt} \sin 2\Omega t] - P \int_0^t e^{-m\tau} \cos 2\Omega \tau \sum_{j=0}^{\infty} (-1)^j \left\{ \operatorname{erfc} \left( \frac{(2j+1)L}{2\sqrt{\nu\tau}} \right) - z + \operatorname{erfc} \left( \frac{(2j+1)L}{2\sqrt{\nu\tau}} + z \right) \right\} d\tau, \quad (11)$$

$$v = \frac{P}{m^2 + 4\Omega^2} [e^{-mt} \sin 2\Omega t - 2\Omega(1 - e^{-mt} \cos 2\Omega t)] + P \int_0^t e^{-m\tau} \sin 2\Omega \tau \sum_{j=0}^{\infty} (-1)^j \left\{ \operatorname{erfc} \left( \frac{(2j+1)L}{2\sqrt{\nu\tau}} \right) - z + \operatorname{erfc} \left( \frac{(2j+1)L}{2\sqrt{\nu\tau}} + z \right) \right\} d\tau. \quad (12)$$

The solutions (11, 12) are convergent for all values of time  $t$ . For  $\nu t/L^2$ , two or three terms are needed for a four place accuracy, so that there are useful in this range and not merely for small values of  $t$ . For large  $\nu t/L^2$ , these solutions are slowly convergent and the expressions (6, 7) are the better.

In the presence of rotation, we find that secondary motion is set in when the flow is unsteady. Several of the non-stationary terms in (6, 7) represent damped oscillations. As  $t \rightarrow \infty$ , the flow is determined by the stationary conditions  $u_{st}$ ,  $v_{st}$  given by (8, 9). When  $m = 0$ , we recover the formula in the hydrodynamic case.<sup>2</sup> When  $\Omega \rightarrow \infty$ , such that  $P/2\Omega$  remains finite, for  $0 < z < L$ ,

$$u = \frac{P}{2\Omega} e^{\alpha(L-z)} \sin \beta(L-z), \quad (13)$$

$$v = \frac{P}{2\Omega} [e^{\alpha(L-z)} \cos \beta(L-z) - 1]. \quad (14)$$

Similar expressions can be written for  $0 < z < -L$ . We note from (13) that the

amplitude of  $u$  is positive and that the function  $\sin \beta(L-z)$  can take +ve or -ve values. For  $\Omega \rightarrow \infty$ , such that  $P/2\Omega$  is finite, the disturbance is confined to regions of order  $1/\alpha$  in the vicinity of the walls. Thus we get a boundary layer at the walls whose thickness is of order  $\left( \frac{\Omega}{\nu} + \frac{\mu^2 H_0^2 \sigma}{2\rho\nu} \right)^{-1/2}$  and is less than that corresponding to the zero magnetic case. Under the same conditions but  $t \rightarrow 0$ , the argument of  $\operatorname{erfc}$  corresponding to  $j=0$  in the integrand of (11, 12) shows that there exists a boundary layer at the walls whose thickness is of order  $\sqrt{\nu t}$ . Thus in a rapidly rotating system at  $t=0$ , the boundary layer thickness grows as  $\sqrt{\nu t}$  and for  $t \rightarrow \infty$ , it settles down to an order of thickness  $\left( \frac{\Omega}{\nu} + \frac{\mu^2 H_0^2 \sigma}{2\rho\nu} \right)^{-1/2}$ .

1. Vidyandhi, V., *Curr. Sci.*, 1968, **37**, 369.
2. — and Nigam, S. D., *J. Math. Phys. Sci.*, 1967, **1**, 85.

# HISTOGENESIS, ORGANOGENESIS AND MORPHOGENESIS IN CALLUS CULTURES OF *TRIGONELLA FOENUM-GRÆCUM* LINN. AND *VIGNA UNGUICULATA* (L.) WALP.

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**D**URING the past decade attempts to obtain plantlets from cell cultures have met with some success. The plantlets originating from the freely suspended cells of the Carrot were found to be diploid and their nuclei cytologically equivalent to "the nuclei of the storage root from which the cell cultures originated".<sup>1</sup> It was surmised that the plantlets should have originated from the diploid cells in culture.

The cells of the differentiated tissues of many plants exhibit polysomaty<sup>2,3</sup> and the polyploid cells found in tissue cultures are considered to be the descendants of these cells.<sup>4</sup> Tetraploid tobacco plants have been produced from isolated single pith cells of diploid plants. On this basis, while the plantlets originating from the calli of root and shoot meristems would be diploid, those from the other regions may be diploids or polyploids.<sup>5</sup> It is generally believed to be difficult to obtain calli from the root and shoot meristems.<sup>6</sup> The successful production of cell cultures from the hypocotyl and root meristem of *T. foenum-græcum*, from the root and shoot meristem of *V. unguiculata* and the histogenesis, organogenesis and morphogenesis observed in these cultures are detailed below.

The methods employed to obtain sterile seedlings have been presented earlier.<sup>7</sup> Production of calli from different regions of the same species and from the same region of different species necessitated not only alteration of the composition of White's<sup>8</sup> and Murashige and Skoog's<sup>9</sup> media but also supplementation. For convenience, the following abbreviations are used in the descriptions. TWM I—Modified White's medium used for root culture.<sup>7</sup> MWM II—The above with its composition considerably altered and supplemented with casein hydrolysate, coconut milk, IAA and Kinetin. MS I—Medium of Murashige and Skoog without edamine but with coconut milk. MS II—The above with additional amounts of glycine and vitamins but without myo-inositol. MS III—Same as MS I but without IAA.

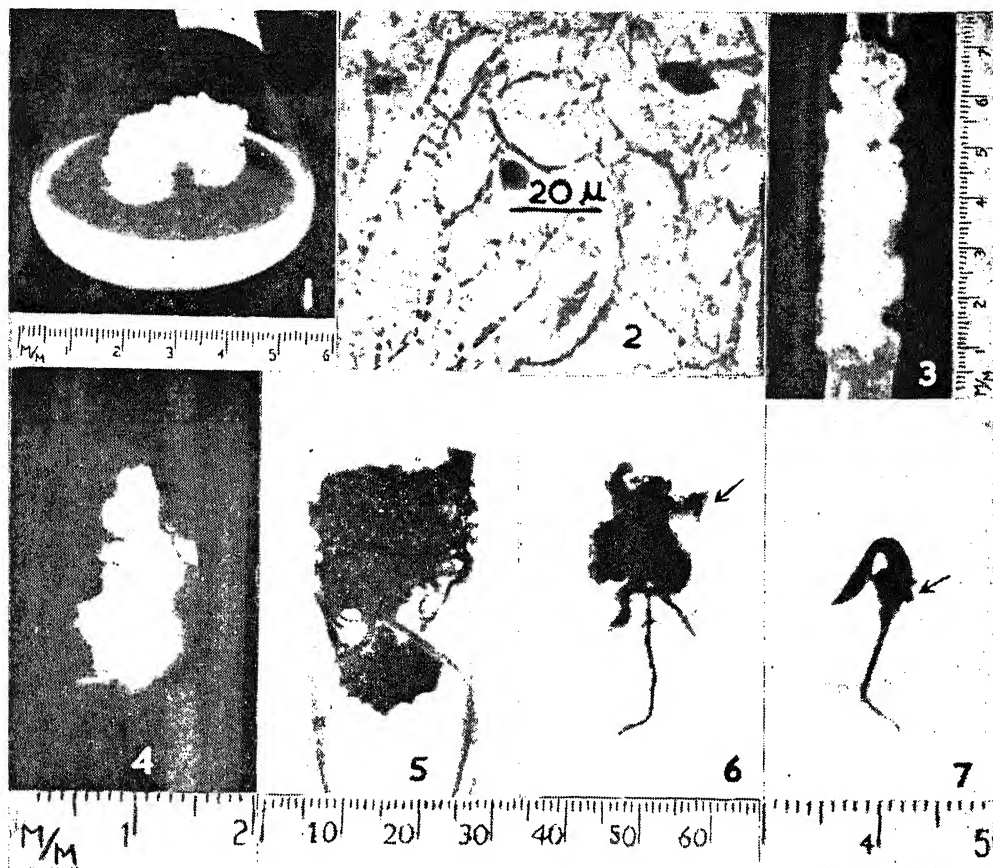
**Histogenesis.**—Transverse slices of the hypocotyl of 4-day old seedlings of *T. foenum-græcum* (ca. 1.5 mm. in thickness and 1.5 mg. in weight) developed into calli when transferred to agar slants of medium, MS I. Photo 1 illustrates the 60-day growth of the first sub-culture. Tracheidal cells (Photo 2) were seen in sections of a 45-day callus from a later sub-culture. Root and shoot formation has not been observed so far. The calli developed chlorophyll on exposure to diffused light.

**Organogenesis.**—After extensive trials MWM II was found suitable for the production and sub-culture of calli from the root meristem of *T. foenum-græcum*. Photo 3 is that of a 40-day old primary culture originating from a thin slice of the root tip weighing ca. 0.3 mg. Exposure to diffused light led to the development of chlorophyll in the cells. In rare instances the calli produced roots. This is illustrated in Photo 4 of a 15-day old primary culture.

Similarly, calli were produced from the root meristem of *Vigna unguiculata* in MS I medium. Photo 5 is that of a 10-day old sub-culture which had developed roots. When transferred to MS III agar slants, the roots grew for a few days but the callus became brown.

**Morphogenesis.**—Many of the calli which developed from the shoot and root meristems inoculated together on MS II slants developed shoots as well as roots. The leaves formed lost their organization when allowed to grow further in the same medium (arrows, Photo 6). Therefore, one of the shoots with a piece of the callus mass was transferred to another MS III slant. As would be seen there is a collar of callus tissue (arrow, Photo 7) between the root and the shoot and it has a fully developed leaf. It is now growing in a flask containing MWM I medium.

Though so far the cultures from the hypocotyl of *T. foenum-græcum* have not produced roots or shoots, those from the root meristem seem



PHOTOS 1-7

to give origin to roots in rare instances. While cultures from the root tips of *V. unguiculata* developed only roots, calli from shoot and root meristems growing together appear capable of producing plantlets.

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1. Mitra, J., Mapes, M. O. and Steward, F. C., *Am. J. Botany*, 1960, **47**, 357.

2. D'Amato, F., *Caryologia*, 1952, **4**, 311.  
3. Royan, S. and Subramaniam, M. K., *Curr. Sci.*, 1954, **23**, 315.  
4. Partanen, C. R., *Internat. Rev. Cytol.*, 1963, **15**, 215.  
5. Murashige, T. and Nakano, R., *J. Hered.*, 1966, **57**, 114.  
6. Torrey, J. G., *Adv. Morphogenesis*, 1966, **5**, 39.  
7. Subramaniam, M. K., Royan-Subramaniam, S., Subramanyam, S. and Meenakshi, G., *Curr. Sci.*, 1966, **35**, 406.  
8. White, P. R., *Plant Tissue Culture*, Cattel, Lancaster, Pa., 1943.  
9. Murashige, T. and Skoog, F., *Physiol. Plant.*, 1962, **15**, 473.

## LETTERS TO THE EDITOR

ELECTRON SPIN RESONANCE IN  
X-IRRADIATED POTASSIUM  
SULPHATE

SINGLE crystals of  $K_2SO_4$  grown from aqueous solutions by repeated crystallisation at room temperature were irradiated with X-rays from a copper target (30 kV, 15 mA) and Electron Spin Resonance spectra of the induced magnetic centers were obtained with X-band spectrometer both at room temperature and liquid nitrogen temperature.  $K_2SO_4$  has 4 molecules per unit cell of dimensions  $a = 5.731$ ,  $b = 10.008$  and  $c = 7.424$  Å. No visible coloration was observed on irradiation.

The observed E.S.R. spectra consist of several lines. Figure 1 shows a typical spectrum taken at room temperature for H parallel to [100] axis in (010) plane. A preliminary analysis of the spectra in different orientations indicated the presence of four different paramagnetic species.

Line A is almost isotropic with  $g = 2.0015 \pm 0.0005$  and has a width of about 3 Gauss. This may be attributed to an electron or hole trapped in a vacancy, most probably in a vacancy near a potassium ion position. This is suggested by the presence of four equally spaced lines of group B centred around  $g = 2.0015$  which appear to be hyperfine lines due to interaction of the unpaired electron with a nucleus of spin  $3/2$ .  $B_1$  and  $B_4$  of this group are of the same intensity, while  $B_2$  and  $B_3$  are of much higher intensity due to overlapping of the lines due to some other species. The hyperfine interaction for this orientation is observed to be 24 Gauss and showed slight anisotropy with orientation of the magnetic field.

The slightly anisotropic line of group c with 'g' centred at 2.012 is assigned to  $O_3^-$  which was present in irradiated  $Na_2SO_4$ <sup>1</sup> also. At liquid nitrogen temperature also the anisotropic line with average g value of 2.010 is observed similar to the spectrum obtained in X-irradiated  $Li_2SO_4$ .<sup>2</sup> However it has to be confirmed from optical absorption measurements also, since  $O_3^-$  is characteristic of an absorption peak at  $460 m\mu$ .<sup>3,4</sup>

The anisotropic lines of group D are assigned to  $SO_4^-$  which is the primary product of radiolysis in  $K_2SO_4$ . Morton *et al.*<sup>5</sup> from their investigations at 77° K. on  $\gamma$ -irradiated  $K_2SO_4$

identified  $SO_4^-$  with principal g values 2.0486, 2.0082 and 2.0037. In a certain orientation their spectra consisted of four lines corresponding to the four magnetically distinguishable sites. This feature is noticed in the present case also as can be seen from the lines of group D. While the spectra of  $K_2SO_4$  irradiated and examined at 77° K. revealed the presence of only a single paramagnetic species identified as  $SO_4^-$ , the spectra of X-irradiated  $K_2SO_4$  revealed many additional paramagnetic centres of which only four are tentatively assigned at present.

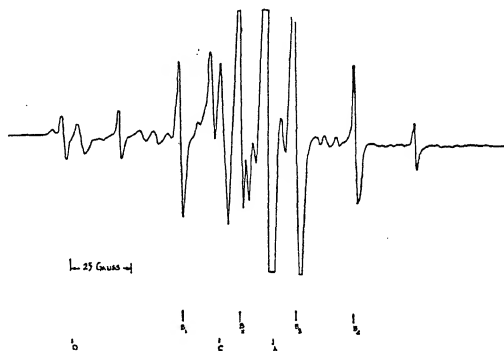


FIG. 1. Derivative of E.S.R. spectra of X-irradiated single crystal of  $K_2SO_4$ . The magnetic field is parallel to 'a' axis in 'ac' plane.

Further analysis concerning the evaluation of the elements of 'g' tensor and 'A' tensor and their fitting into a proper spin-Hamiltonian which are in progress may give more confirming evidence about the assignment of the various radicals.

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Madras, June 7, 1968.

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1. Hariharan, N. and Sobhanadri, J., *Communicated*.
2. — and —, *Ibid.*
3. Ramasastry, C. and Sastry, S. B. S., *J. Phys. Soc., Japan*, 1965, **20**, 2303.
4. Hariharan, N. and Sobhanadri, J., *Ind. J. Pure & Appl. Phys.*, 1968, **6**, 73.
5. Morton, J. R., Bishop David, M. and Randic, M., *J. Chem. Phys.*, 1966, **45**, 1885.

# GENERALIZED MEAN-SQUARE AMPLITUDES OF VIBRATION OF SOME XY<sub>2</sub>Z<sub>2</sub> TYPE MOLECULES

THEORETICAL studies regarding the normal vibrations of XY<sub>2</sub>Z<sub>2</sub> type molecules have been carried out by some investigators.<sup>1-10</sup> This type of molecules come under C<sub>2v</sub> symmetry and the nine fundamental vibrations are distributed as 4a<sub>1</sub> + 1a<sub>2</sub> + 2b<sub>1</sub> + 2b<sub>2</sub>. The elements of mean-square amplitude matrices  $\Sigma$  are obtained<sup>10</sup> applying the secular equation<sup>11</sup>  $|\Sigma G^{-1} - \Delta E| = 0$ . Applying the method developed by Morino and Hirota,<sup>12</sup> expressions are derived for the generalized mean-square amplitudes of vibration, parallel and perpendicular, and the mean cross products. The numerical values evaluated are listed in Table I. The values indicate that parallel

1. Shaffer, W. H. and Herman, R. C., *J. Chem. Phys.*, 1944, 12, 494; 1945, 15, 83.
2. Glockler, G., *Rev. Mod. Phys.*, 1943, 15, 111.
3. Dowling, J. M. and Meister, A. G., *J. Chem. Phys.*, 1954, 22, 1042.
4. Voltz, E., Cleveland, F. F. and Meister, A. G., *J. Opt. Soc. Amer.*, 1953, 43, 1061.
5. Pace, E. L., *J. Chem. Phys.*, 1950, 18, 881.
6. Dowling, J. M., *Ibid.*, 1954, 22, 1789.
7. Deiker, C. E., Meister, A. G. and Cleveland, F. F., *Ibid.*, 1953, 21, 1781.
8. Venkateswarlu, K. and Thirugnanasambandam, P., *Zeit. Physik. Chem.*, 1957, 13, 234.
9. Davis, A., Cleveland, F. F. and Meister, A. G., *J. Chem. Phys.*, 1952, 24, 54.
10. Venkateswarlu, K. and Malathy Devi, V., *Ind. J. Pure and Appl. Phys.*, 1965, 3, 195.
11. Cyvin, S. J., *Acta Polytech. Scand. Ph.*, 1960, 6, 279.
12. Morino, Y. and Hirota, E., *J. Chem. Phys.*, 1952, 20, 726.

TABLE I  
Generalized mean-square amplitudes of vibration ( $\text{\AA}^2$ ) for some XY<sub>2</sub>Z<sub>2</sub> type molecules

Bond	Designation	SO <sub>2</sub> F <sub>2</sub>	SO <sub>2</sub> Cl <sub>2</sub>	SiH <sub>2</sub> D <sub>2</sub>	SiH <sub>2</sub> Cl <sub>2</sub>	SiH <sub>2</sub> Br <sub>2</sub>
X—Z ..	$\langle(\Delta z)^2\rangle$	0.001833	0.002638	0.006222	0.002605	0.003021
	$\langle(\Delta x)^2\rangle$	0.000821	0.001221	0.002094	0.001024	0.001900
	$\langle(\Delta y)^2\rangle$	0.001066	0.000751	0.003618	0.000220	0.000013
	$\langle(\Delta z \Delta x)\rangle$	-0.000055	0.000075	0.000515	-0.000103	-0.000273
X—Y ..	$\langle(\Delta z)^2\rangle$	0.001575	0.001580	0.007718	0.007701	0.007757
	$\langle(\Delta x)^2\rangle$	0.000488	0.003366	0.030014	0.018981	0.017362
	$\langle(\Delta y)^2\rangle$	0.001318	0.002573	0.012068	0.021224	0.024816
	$\langle(\Delta z \Delta x)\rangle$	-0.000163	-0.000269	-0.000349	-0.001037	-0.001059
Z...Z ..	$\langle(\Delta z)^2\rangle$	0.004371	0.007191	0.017370	0.015380	0.021320
	$\langle(\Delta x)^2\rangle$	0.000688	0.000321	0.005387	0.000246	0.000097
	$\langle(\Delta y)^2\rangle$	0.003542	0.000692	0.006127	0.000022	0.000004
	$\langle(\Delta z \Delta x)\rangle$	0	0	0	0	0
Y...Y	$\langle(\Delta z)^2\rangle$	0.003399	0.003716	0.021170	0.016690	0.017080
	$\langle(\Delta x)^2\rangle$	0.001024	0.002262	0.017066	0.034531	0.040745
	$\langle(\Delta y)^2\rangle$	0.004199	0.005907	0.024510	0.049560	0.031960
	$\langle(\Delta z \Delta x)\rangle$	0	0	0	0	0
Y...Z	$\langle(\Delta z)^2\rangle$	0.002999	0.004131	0.018610	0.014930	0.015640
	$\langle(\Delta x)^2\rangle$	0.002536	0.003187	0.019853	0.017987	0.020020
	$\langle(\Delta y)^2\rangle$	0.001333	0.002247	0.027750	0.018967	0.012152
	$\langle(\Delta z \Delta x)\rangle$	0.000536	-0.000045	0.002533	-0.005067	-0.008565
	$\langle(\Delta z \Delta y)\rangle$	-0.000469	-0.002396	-0.008049	-0.002636	-0.004059
	$\langle(\Delta x \Delta y)\rangle$	0.000791	-0.000248	-0.003817	-0.002456	-0.003060

mean-square amplitudes are more characteristic of the bonds. All cross terms vanish for Z...Z and Y...Y non-bonded atom pairs while all the three cross products exist for the Y...Z atom pair and only  $\langle(\Delta z \Delta x)\rangle$  term is present for the bonded pairs of atoms. This may be due to the symmetry of the system.

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## ABSOLUTE PHOTOELECTRIC CROSS- SECTIONS OF 280 keV GAMMA-RAYS IN Ta, Cd AND Cu

With the availability of more and more accurate theoretical data on total photoelectric cross-sections, the need for experimental investigations on them is also increasing. Out of the available methods<sup>1-3</sup> for a direct experimental measurement of absolute photoelectric cross-sections utilising simple scintillation technique, the method employed by Titus<sup>1</sup> seems to be well suited. Utilising an experimental technique<sup>4</sup> similar to that of the previous workers<sup>1,2</sup> for measurement of photo-

electron intensity, and internal conversion technique<sup>4</sup> for the measurement of gamma intensity, photoelectric cross-sections in Ta, Cd and Cu at gamma energy 280 keV have been determined and the results are reported here.

Hg<sup>203</sup> isotope was obtained in a liquid form from the Atomic Energy Establishment, Bombay. The total beta-ray spectrum was first recorded. Utilising a coincidence technique, beta-gamma coincidence spectrum was next recorded. The second spectrum

necessary corrections the photoelectric cross-sections were determined in Ta, Cd and Cu. These results, along with the theoretical results of previous authors,<sup>7-10</sup> are given in Table I. The K-shell cross-sections using Nagel's<sup>7</sup> expressions were evaluated on computers. These values, as suggested by Hultberg,<sup>11</sup> have been multiplied by the ratios, total photoelectric cross-section to K-shell photoelectric cross-section,<sup>12,13</sup> to get the final results shown in Table I.

TABLE I  
Photoelectric cross-sections of gamma-rays at 280 keV in barns per atom

Element	Present experimental value	Schmickley and Pratt <sup>9</sup>	Rakavy and Ron <sup>8</sup>	Nagel <sup>7</sup>	Hubbell and Berger <sup>10</sup>
Ta ..	75.75 ± 5.40	76.00 ± 0.80	76.60 ± 0.80	75.20 ± 1.50	75.20 ± 2.30
Cd ..	12.55 ± 0.90	12.80 ± 0.10	12.90 ± 0.10	12.80 ± 0.30	13.10 ± 0.40
Cu ..	1.31 ± 0.11	1.35 ± 0.01	1.35 ± 0.01	1.35 ± 0.03	1.40 ± 0.04

was normalised to the peak intensity of the beta group of the first spectrum and then subtracted from the first spectrum. The difference spectrum gives the true conversion electron spectrum. After effecting necessary corrections to the estimated intensity of the conversion electrons from the difference spectrum, the gamma-ray intensity was estimated using the experimental internal conversion coefficient.<sup>5,6</sup> Then the electron spectra were taken with external converters Ta (8.73 mg./cm.<sup>2</sup>), Cd (11.97 mg./cm.<sup>2</sup>) and Cu (17.18 mg./cm.<sup>2</sup>). Spectra were also recorded with Al foils having equal number of electrons in the respective external converter foils. The respective difference spectra would be the photoelectron spectra of the concerned elements. A typical spectrum taken in Cd is shown in Fig. 1. The

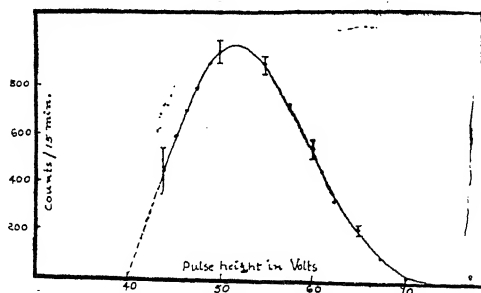


FIG. 1. Photoelectron spectrum in cadmium.

Photoelectron intensity was estimated from these difference spectra, and after applying

It can be seen from Table I that there is satisfactory agreement between the present experimental values and the theoretical as well as the compiled data.

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for Nuclear Research, K. PARTHASARADHI.  
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Waltair (India),  
April 11, 1968.

1. Titus, W. F., *Phys. Rev.*, 1959, **115**, 351.
2. Parthasaradhi, K. *et al.*, *Ibid.*, 1966, **142**, 9.
3. Ghuman, B. S. *et al.*, *Curr. Sci.*, 1968, **37**, 11.
4. Raja Rao, M., "Experimental Studies on Internal Conversion," *Ph.D. Thesis*, Andhra University, 1964.
5. Nijgh, G. J. *et al.*, *Nucl. Phys.*, 1959, **9**, 528.
6. Croft, W. L. *et al.*, *Ibid.*, 1963, **48**, 267.
7. Nagel, C. H., *Arkiv For Fysik*, 1960, **18**, 1.
8. Rakavy, G. and Ron, A., *Phys. Rev.*, 1967, **50**, 159.
9. Schmickley, R. D. and Pratt, R. H., *Tables of Calculated Photoelectric Cross-sections from 10 to 3,000 keV*, Lockheed Missiles and Space Company, U.S.A., 1967.
10. Hubbell J. H. and Berger, M., *Photon Attenuation Coefficients: Tables and Discussion* (Engineering Compendium on Radiation Shielding), Springer Verlag Company, 1967.
11. Hultberg, S., *Arkiv For Fysik*, 1959, **15**, 307.
12. Davisson, C. M., *Alpha, Beta, Gamma-ray Spectroscopy*, 1965, **1**, Chapter II, 47.
13. Kirchner, F., *Handbuch der Experimental Physik*, 1930, **24**, 1.



COMPLEXES OF URANYL ION WITH  
VARIOUS CARBOXYLIC ACIDS

As a part of our studies on complexes of uranyl ion with organic acids, systems of uranyl ion with various acids (see Table I) were studied by pH titration method at 31° C. and  $\mu = 0.1$  ( $\text{NaClO}_4$ ) with a view to determine the composition (s) and formation constant (s) of the complex (es) in the pH range 1.5–3.5 in which the hydrolysis of uranyl ion may be completely neglected.

A Leeds and Northrup pH meter (cat. no. 7666) with glass and calomel electrodes and standardized against 0.05 M potassium hydrogen phthalate solution (pH 4.01 at 31° C.) was used in the pH titrations. Uranyl perchlorate prepared by standard procedure<sup>1</sup> and estimated by Jones's reductor for uranyl content<sup>2</sup> and cation resin exchange for free acid content<sup>3</sup> was used as a source of uranyl ion. Carbonate-free sodium hydroxide was used as the titrant. All ligand acids were of analytical grade.

Dissociation constants of ligand acids and stability constants of various complexes were evaluated graphically as well as by least squares from the values of  $\bar{n}_{11}$  and  $\bar{n}$  by Irving and Rossotti's method.<sup>4</sup> The results are tabulated in Table I, along with those

succinic and maleic acids were obtained under somewhat different experimental conditions of ionic strength (1M  $\text{KNO}_3$ ) and temperature (25° C.), ( $\log K_{ML_1}$  and  $\log K_{ML_2}$  for  $\text{UO}_2^{++}$ -malonic acid, 5.66, 4.00 and  $\log K_{ML_1}$  for  $\text{UO}_2^{++}$ -succinic,  $\text{UO}_2^{++}$ -maleic acids are 3.68 and 4.46 respectively).

From our results, we may conclude that:

(i) in  $\text{UO}_2^{++}$ -simple monocarboxylic acids (formic, propionic, benzoic and phenyl acetic acids) systems, the pK of the ligand acid is of the order formic < benzoic < phenyl acetic < propionic while  $K_{ML_1}$  is formic = benzoic < phenyl acetic > propionic acid.

(ii) in  $\text{UO}_2^{++}$ -monocarboxylic acids contain-

ing  $-\text{O}-$  and  $-\text{C}(=\text{O})-$  groups (phenoxy acetic and pyruvic acids),  $\text{UO}_2^{++}$ -phenoxy acetic acid system differed very much from  $\text{UO}_2^{++}$ -pyruvic acid in number of complexes formed as well as the stability range of the latter. Though the stability range of these systems showed the non-involvement of oxygen atom in co-ordination, probable stabilization by keto oxygen in  $\text{UO}_2^{++}$ -pyruvic acid was inferred from the facts that precipitation did not occur till pH 10.5 and complexation was considerable at low pH.

TABLE I

Dissociation constants of ligand acids and metal-ligand stability constants

Metal =  $\text{UO}_2^{++}$

$\mu = 0.1$  ( $\text{NaClO}_4$ ).  $T = 30 \pm 0.1^\circ \text{C}$ .

Ligand	Author's values		Literature		Author's values	
	$pK_1$	$pK_2$	$pK_1$	$pK_2$	$\log K_{ML_1}$	$\log K_{ML_2}$
1. Formic acid	3.54	..	..	..	2.61	..
2. Benzoic acid	4.01	..	4.01 <sup>7</sup>	..	2.57	..
3. Phenyl acetic acid	4.12	..	..	..	3.21	..
4. Propionic acid	4.62	..	..	..	3.03	..
5. Phenoxy acetic acid	2.96	..	..	..	2.59	..
6. Pyruvic acid	2.39	..	..	..	2.15	0.59
7. Malonic acid	2.81	5.14	..	..	5.28	4.01
8. Succinic acid	3.87	5.12	..	..	4.48	..
9. Adipic acid	4.12	5.04	4.28	5.00 <sup>7</sup>	4.08	..
10. Itaconic acid	3.61	4.98	3.68	5.14 <sup>7</sup>	4.36	..
11. Thiomalic acid	2.95	4.45	..	..	3.71	..
12. Maleic acid	1.95	6.16	..	..	5.15	..
13. Fumaric acid	2.89	4.11	..	..	3.05	..
14. Diglycolic acid	2.77	3.88	2.77	3.92 <sup>7</sup>	4.90	2.84
15. Crotonic acid	4.53	..	..	..	2.74	2.53

Literature values obtained under comparable experimental conditions of ionic strength and temperature. It may be mentioned that we are reporting thirteen equilibrium constants for the first time, though reported data<sup>5</sup> on the stability constants in the case of malonic,

(iii) in  $\text{UO}_2^{++}$ -simple dicarboxylic acids (malonic, succinic and adipic acids), stability of the chelate ring decreases with increase in ring size, i.e., from malonic  $\rightarrow$  adipic acid and formation of 1:2 complex ( $\text{UO}_2^{++}$ -malonic acid) may be due to least steric hindrance.

(iv) in  $\text{UO}_2^{++}$ -substituted dicarboxylic acids (thiomalic and itaconic acids<sup>6</sup>), the chelate ring is stabilized by the presence of a double bond or by a  $-\text{SH}$  group and more so by the former.

(v) in  $\text{UO}_2^{++}$ -cis and trans dicarboxylic acids (maleic and fumaric acids), maleic acid formed a seven-membered chelate ring with  $\text{UO}_2^{++}$  while fumaric acid, being a trans isomer formed only a complex (not a chelate).

(vi) in  $\text{UO}_2^{++}$ -dicarboxylic acid containing  $-\text{O}-$  (diglycolic acid), diglycolic acid forms a chelate with  $\text{UO}_2^{++}$  with additional stabilization through  $-\text{O}-$  group as evident from  $K_{\text{ML}}$  value.

(vii) in  $\text{UO}_2^{++}$ -unsaturated carboxylic acid (crotonic acid), the higher stability of the system may be due to higher basicity of the ligand due to inductive effect of the methyl group as well as double bond.

In general, it may be stated that basicities of the monodentate ligands have very little influence on the stabilities of the corresponding  $\text{UO}_2^{++}$  complexes. Steric factors and ring size presumably determine the metal chelate stabilities with bidentate ligands.

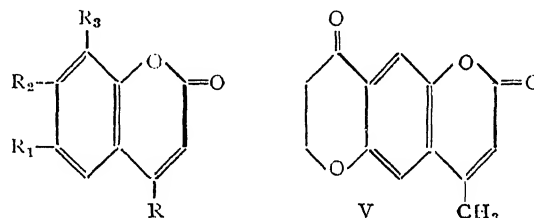
Dept. of Physical Chem., S. RAMAMOORTHY.  
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Technology Buildings,  
Madras-25, April 12, 1968.

1. Heidt, J. and Moon, A., *J. Am. Chem. Soc.*, 1953, **75**, 5803.
2. Vogel, A. I., *Text-Book of Quantitative Inorganic Analysis*. Longmans Green & Co., Ltd., 1962, p. 333.
3. Bhatnagar, D. W., *J. Sci. and Ind. Res.*, India, 1957, **16B**, 23.
4. Irving, H. M. and Rossotti, H. S., *J. Chem. Soc.*, 1954, p. 2904; Irving, H., and Rossotti, H. S., *Ibid.*, 1953, p. 3397; Rossotti, F. J. C. and Rossotti, H. S., *Acta Chem. Scand.*, 1955, **9**, 1166.
5. Rajan, K. S. and Martell, A. E., *J. Inorg. Nucl. Chem.*, 1967, **29**, 523.
6. Ramamoorthy, S. and Santappa, M., *Curr. Sci.*, 1966, **35**, 145.
7. Yasuda, M., Yamasaki, K., and Ohtaki, H., *Bull. Chem. Soc.*, Japan, 1960, **33**, 1067.

## CYANOETHYLATION OF COUMARINS

In connection with our work on the application of cyanoethylation in the synthesis of polynuclear compounds, we investigated the cyanoethylation of some coumarin derivatives.

When 7-hydroxycoumarin was reacted with acrylonitrile in alkaline solution the compound I was obtained as a crystalline solid (m.p. 167-69°, Found C, 67.3; H, 4.4; N, 6.9;  $\text{C}_{12}\text{H}_9\text{NO}_3$  requires C, 67.0; H, 4.2; N, 6.5%). On hydrolysis with acid the corresponding acid II was formed (m.p. 164-66°, Found C, 61.8; H, 4.6;  $\text{C}_{12}\text{H}_{10}\text{O}_5$  requires C, 61.5; H, 4.3%).



- I  $\text{R}=\text{R}_1=\text{R}_3=\text{H}$ ;  $\text{R}_2=\text{OCH}_2\text{CH}_2\text{CN}$   
 II  $\text{R}=\text{R}_1=\text{R}_3=\text{H}$ ;  $\text{R}_2=\text{OCH}_2\text{CH}_2\text{COOH}$   
 III  $\text{R}=\text{R}_2=\text{H}$ ;  $\text{R}=\text{CH}_3$ ;  $\text{R}_1=\text{OCH}_2\text{CH}_2\text{CN}$   
 IV  $\text{R}_2=\text{R}_3=\text{H}$ ;  $\text{R}=\text{CH}_3$ ;  $\text{R}_2=\text{OCH}_2\text{CH}_2\text{COOH}$   
 VI  $\text{R}=\text{R}_1=\text{R}_2=\text{H}$ ;  $\text{R}_3=\text{OCH}_2\text{CH}_2\text{CN}$   
 VII  $\text{R}=\text{R}_1=\text{R}_2=\text{H}$ ;  $\text{R}_3=\text{OCH}_2\text{CH}_2\text{COOH}$

Similarly 6-hydroxy-4-methylcoumarin when cyanoethylated afforded the compound III (m.p. 138-40°; Found C, 68.5; H, 4.4; N, 5.8;  $\text{C}_{13}\text{H}_{11}\text{NO}_3$  requires C, 68.1; H, 4.8; N, 6.1%) which on hydrolysis gave the acid IV (m.p. 172-74°; Found C, 63.3; H, 5.2;  $\text{C}_{13}\text{H}_{12}\text{O}_5$  requires C, 62.9; H, 4.8%). It is interesting to note that when the acid IV or the compound III is boiled with alkali the original coumarin is obtained back. Cyclisation of the acid IV was attempted under different conditions such as treatment with  $\text{P}_2\text{O}_5$ ,  $\text{POCl}_3$  and so on. However, on heating with polyphosphoric acid the cyclisation occurred to give the chromanone V (m.p. 210-12°; Found C, 68.0; H, 4.6;  $\text{C}_{13}\text{H}_{10}\text{O}_4$  requires C, 67.8; H, 4.4%) which was further characterised by the preparation of a 2,4-dinitrophenylhydrazone (m.p. 298-300°; Found N, 13.3;  $\text{C}_{19}\text{H}_{14}\text{N}_4\text{O}_7$  requires N, 13.7%). The linear structure for V was favoured by making models and also on the basis of spectral data.

$\lambda_{\text{max}}^{\text{MeOH}}$  370, 290, 220 ( $\log \epsilon$  3.61, 4.26, 4.33).

In the same manner 8-hydroxycoumarin on cyanoethylation gave the nitrile VI (m.p. 139-40°; Found C, 67.0; H, 4.5; N, 6.4;  $\text{C}_{12}\text{H}_9\text{NO}_3$

ires C, 67.0; H, 4.2; N, 6.5%) which on  
olysis yielded the acid VII (m.p. 173-75°;  
d C, 61.4; H, 4.6; C<sub>12</sub>H<sub>10</sub>O<sub>5</sub> requires C,  
; H, 4.3%).

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# LIPID AND ELECTROLYTE COMPOSITION OF DIFFERENT PORTIONS OF THE RABBIT FALLOPIAN TUBE

a previous communication the biochemical  
osition of different portions of the rabbit  
opian tube has been reported.<sup>1</sup> A note-  
thy feature is the marked acid phosphatase  
ivity in the ampullary-isthmus junction  
I) where ova are known to be retained  
as long as 36 hr. following a rapid post-  
atory passage through the ampulla (A).<sup>1,2</sup>  
he present note the lipid and electrolyte  
tituents of the three portions of the rabbit  
opian tube are described.

small amounts of lipid have been reported  
in bovine tube but not in sheep.<sup>3,4</sup> In the  
opian tube of rhesus monkeys appreciable  
ities of lipids have been observed but  
significant alteration in their concentration  
been noticed during the two stages of the  
strual cycle.<sup>5,6</sup> Histochemical<sup>7</sup> and electron-  
oscopic<sup>8</sup> studies of the human Fallopian  
have demonstrated scattered lipid granules  
in the cytoplasm of the epithelium, particularly  
in the basal area of the secretory cells. Only

in rhesus monkeys the electrolyte composition  
of the tube has been studied but, again, no  
cyclic variation in their level has been  
observed.<sup>5,6</sup> In these investigations no atten-  
tion has, however, been paid individually to  
the A, AIJ and isthmus (I) portions of the  
Fallopian tube.

Colony bred adult virgin estrus rabbits  
(1.3-1.7 kg.) were used in this investigation.  
They were maintained in air-conditioned  
quarters (75° ± 2° F.) under standard husbandry  
conditions prior to sacrifice. The procedure  
for anatomic demarcation of the three portions  
of the Fallopian tube, and the methods for  
estimation of lipids and electrolytes have been  
described previously.<sup>1,5,6</sup>

It will be evident from the results presented  
in Table I that all the lipid constituents  
tended to show lower values in the AIJ as  
compared to A or the I portions. This was  
particularly the case with total and free sterols  
which were 25 to 31% less than those of the  
A or I portions. The level of lipids in the  
latter parts (A and I) was more or less com-  
parable. The pattern was similar with sodium,  
potassium and chloride: a low concentration  
in the AIJ *vis-a-vis* the other two portions.  
The values of A and I were not appreciably  
different. In contrast, the concentration of  
calcium was lowest in the A and highest in  
the I portion; the AIJ occupied an intermediate  
position in this respect. The high calcium  
level in the I is interesting and may be related  
to the vigorous sphincter-like muscular activ-  
ity and rich adrenergic innervation of this  
portion not seen in the A.<sup>9</sup>

TABLE I

*Lipid and electrolyte constituents of different portions of the rabbit Fallopian tube*

Constituents	Ampulla	Ampullary-isthmus junction	Isthmus
l lipids (% of wet wt)	20.8† (19.0- 23.9)	15.5 (12.8- 19.3)	22.6 (20.0- 28.6)
lycerides*	26.5 (26.1- 27.2)	24.5 (23.5- 25.1)	28.2 (27.1- 29.3)
l esters*	20.4 (19.7- 21.1)	16.6 (16.2- 17.3)	18.4 (17.8- 19.2)
sterols*	6.7 (6.3- 7.1)	4.6 (4.1- 5.0)	6.1 (5.5- 6.7)
um (Mg./100 gm)	245.0 (241.1-249.5)	205.4 (202.2-210.1)	277.9 (274.3-280.0)
ssium (Mg./100 gm.)	145.2 (141.1-150.2)	115.0 (111.3-118.5)	137.4 (133.2-140.8)
ride (Mg./100 gm.)	126.6 (121.1-131.2)	112.8 (111.7-114.4)	135.2 (129.3-139.9)
um (Mg./100 gm.)	11.8 (9.8- 13.5)	14.5 (11.1- 17.2)	24.9 (21.5- 27.3)

\* Values expressed as % of total lipids. † Mean with range in parenthesis.

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Institute, J. N. KARKUN.  
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April 22, 1968. AMIYA B. KAR.

1. Gupta, D. N., Karkun, J. N. and Kar, A. B., *Indian J. Exp. Biol.*, 1967, 5, 124.
2. Greenwald, G. S., *Fert. Steril.*, 1961, 12, 80.
3. Weath, H. J., *Thesis*, Univ. of Missouri (*Biol. Abst.*, 1953, 27, 12588).
4. Hadek, R., *Anat. Rec.*, 1955, 121, 187.
5. Kar, A. B., Chowdhury, S. R., Kamboj, V. P., Chandra, H. and Chowdhury, A. R., *Endokrinol.*, 1966, 49, 137.
6. —, Kamboj, V. P., Chowdhury, S. R., Chandra, H. and Chowdhury, A. R., *Amer. J. Obst. Gynecol.*, 1967, 98, 194.
7. Fredrickson, B., *Acta Obst. Gynecol. Scand.*, 1959, 38, 109.
8. Clyman, M. J., *Fert. Steril.*, 1966, 17, 281.
9. Brundin, J., *Acta Physiol. Scand.*, 1965, 66, 1 (Suppl.).

### AN EXTRA FUNGAL SOURCE OF AFATOXINS

AFATOXINS are a group of carcinogenic compounds produced by some strains of *Aspergillus flavus* as well as certain other fungi associated with spoilage of agricultural commodities.<sup>1,2</sup> So far, fungi are the only organisms that have been shown to produce these toxic and carcinogenic metabolites.

In the course of studies on the pathogenicity of aerobic actinomycetes associated with human respiratory tract, a strain identified as *Streptomyces* species killed the mice within a very short period when saline extract of the organism was intraperitoneally injected in a very small dose. Autopsy revealed a very high degree of cirrhosis of liver. This prompted us to investigate for the presence of the toxins in the *Streptomyces* species. This observation is important as till now no reports are available in literature to show the production of aflatoxins by either *Streptomyces* species or by any other bacterium.

The organism was isolated from the sputum of an undiagnosed patient of bronchopulmonary disease. The organism, a non-acid fast,

branching filament, less than one micron in breadth was identified as *Streptomyces* species on the basis of its morphological and biochemical characters.<sup>3</sup> The bacterium was grown on stationary culture at 37° C. for 6 weeks on a synthetic liquid medium of the following composition: 2 g. of NaNO<sub>3</sub>, 0.8 g. of K<sub>2</sub>HPO<sub>4</sub>, 0.5 g. of MgSO<sub>4</sub>, 10 mg. of FeCl<sub>3</sub>, 2 mg. of ZnSO<sub>4</sub>·7H<sub>2</sub>O, 8 mg. of MnCl<sub>2</sub>·4H<sub>2</sub>O, 40 g. of glucose and distilled water one litre, pH being 7.2. The culture was filtered and the filtrate and the mycelium were extracted with chloroform according to the procedure described for the extraction of aflatoxins.<sup>4</sup> The chloroform extract was concentrated under reduced pressure and a portion spotted on thin layer plates made of 250 μ layer of Kieselguhr G (Merck AG) and the plates were developed in 2% methanol in chloroform. Standard aflatoxins (kindly supplied by Dr. Goldblatt, United States Department of Agriculture, S.U.R.D.D., New Orleans, Louisiana) were co-chromatographed on the same plate along with chloroform extracts. Presence of aflatoxins B and G were observed on the thin layer plates. The aflatoxin bands detected by fluorescence under ultraviolet light were scraped off and eluted with methanol and made up to a definite volume. Ultraviolet absorption<sup>5</sup> was taken by a Beckman spectrophotometer (Model Du) at 363 mμ and characteristic absorption for aflatoxin was obtained confirming the presence of intensely fluorescent aflatoxins in the *Streptomyces* species. In addition, the finding was confirmed by injecting 25 μg. of the toxin in 0.2 ml. of propylene glycol, in each of a group of 5 white mice. The mice died within 24 to 48 hr. Histopathology of the liver showed cirrhosis marked with characteristic fatty change.<sup>6</sup>

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University of Delhi, H. S. R. MURTHY.  
Delhi-7, April 18, 1968.

1. Wogan, G. N., *Federation Proc.*, 1966, 25, 125.
2. Hodges, F. et al., *Science*, 1964, 145, 1430.
3. Hesselstine, C. W., Benedict, R. G. and Prichan, T. G., *Ann. N.Y. Acad. Sci.*, 1954, 60, 136.
4. Robinson, J. A., Pousjer, W. B. and Goldblatt, L. A., *Agriculture and Food Chemistry*, 1967, 15, 798.
5. Nabany, J. and Nesbitt, B. R., *The Analyst*, 1956, 90, 155.
6. Tulpule, P. G., Madhavan, T. V. and Gopalan, C., *The Lancet*, 1964, p. 962.

## NITROGEN ENRICHMENT IN SLUDGE BY BACTERIZATION

BACTERIAL fertilizers have been applied to soil and seeds in order to enrich them with nitrogen either to stimulate plant growth or to combat the attack on plants by various pathogenic fungi and bacteria.<sup>1,2</sup>

In a local poultry farm the problem of sewage disposal has been solved to a certain extent and the dried pulverised sludge has been used as a fertilizer.<sup>3</sup> In this farm gainful use is made of methane gas produced during the digestion period. The nitrogen content of the manure was low and therefore an attempt was made to increase the level of nitrogen by bacterization with *Azotobacter chroococcum*. Samples of undigested and digested sludge were made available from Patel Poultry Farm, Baroda.

24 hr. grown culture of *Azotobacter chroococcum* was incubated for six days at 30°C. on a rotary shaker containing 1 gm. of sludge in 50 ml. of the following sucrose-salt medium; sucrose, 22 g.;  $\text{KH}_2\text{PO}_4$ , 0.2 g.;  $\text{K}_2\text{HPO}_4$ , 0.8 g.;  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ , 0.2 g.;  $\text{NaCl}$ , 0.2 g.;  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ , 0.0086 g.;  $\text{CuSO}_4 \cdot 2\text{H}_2\text{O}$ , 0.225 g.;  $\text{Na}_2\text{MoO}_4$ , 0.0025 g.; and distilled water to 1 litre (pH adjusted to 7.2). At the end of incubation, 5 ml. of the medium was digested with concentrated  $\text{H}_2\text{SO}_4$  in presence of  $\text{CuSO}_4$ . The digested material was diluted to 25 ml., and 5 ml. were taken for nitrogen analysis by microkjeldahl's method. The necessary controls were maintained.

TABLE I  
Effect of bacterization on undigested sludge

Combination	Initial nitrogen content mg./g. undigested sludge	Final nitrogen content mg./g. undigested sludge
(A)	2.24	9.8
(B)	2.52	5.3
(C)	..	3.08
(D)	2.8	2.88
(E)	2.8	7.0

(A) = 50 ml. of sugar-salts medium + 1 g. of sterile undigested sludge, (B) = 50 ml. of sugar-salts medium + 1 g. of undigested sludge, (C) = 50 ml. of sugar-salts medium, (D) = 50 ml. of sugar-salts medium + 1 g. of undigested sludge (without bacterial inoculation), (E) = 50 ml. of distilled water + 1 g. of undigested sludge.

Results recorded in Table I indicate that there was more than 4 times increase in nitrogen content in the sample containing sterilized sludge; the microflora present in the unsteri-

lized sludge were perhaps inhibitory to the nitrogen fixing activity of *Azotobacter*. In the absence of the sugar-salts medium the nitrogen was fixed due to carbohydrate and minerals present in the sludge itself.

It was found that in the static flasks there was a decrease in the amount of nitrogen fixed. Further, it was found that the optimum incubation time required was six days.

The undigested sludge was substituted by the digested one and the results listed in Table II indicate that there was nitrogen enrichment to the extent of 34-47 times in the digested sludge.

TABLE II  
Effect of bacterization on digested sludge

Sludge nitrogen content g./100 g. sludge	
Before bacterization	After bacterization
0.02	0.95
0.05	1.7

Our thanks are due to Shri J. D. Patel of Patel Poultry Farm, Baroda, for supplying us the samples of sludge.

Department of Microbiology,  
Faculty of Science,  
M.S. University of Baroda,  
Baroda-2, April 5, 1968.

V. R. RAO.  
V. V. MODI.

1. Mishustin, E. N. and Noumova, A. N., *Mikrobiologiya*, 1962, **31**, 543.
2. Menkina, R. A., *Ibid.*, 1963, **32**, 352.
3. Patel, J. D., *Poultry Tribune*, M/s. WATT Publishing, Mount Morris, Illinois 61054, U.S.A., December 1966, p. 31.

## A MINIATURE FILTER FOR STERILISATION OF SMALL QUANTITIES OF LIQUID

STERILISATION of small volumes of liquids could be done by using filters now available in the foreign market such as the Boerner centrifugal filter, Swinex (Millipore) and the like. The present article suggests another cheap and simple device which can be made either in glass or in plastic (of type not affected by acetone) and will be of use where small quantities of sterile liquids are needed.

The apparatus consists of two cylindrical glass or plastic tubes with ground flanges at one end. The upper cylinder is open at both ends and the lower closed at the bottom. Inner diameter of glass cylinder 1.2 cm. Upper tube 4 cm., lower tube 5 cm., diameter of flanges 2.6 cm. (Fig. 1). Between the flanges is kept

TABLE I

Type of solution	Minimum qty. of solution required	Revolutions per minute*	Approximate yield of sterile filtrate
Serum	1 ml.	1,500 for 5 minutes	0.75 ml.
Solutions such as broth and salt solutions	1 ml.	1,000 for 2 minutes	0.75 ml.

\* High speed and long duration may be avoided as they may result in recontamination of filtrate.

an hour and slipped in. It holds the flanges tight as it hardens in about two hours.

The entire assembly is sterilized by autoclaving or by ethylene oxide if made of plastic. The solution to be sterilized is taken in the upper cylinder and the unit is centrifuged. Then, the polythene tubing is slightly warmed over a burner and removed by cutting it off. The sterile filtrate can be pipetted out from the lower tube.

The minimum quantity required, the speed and duration of centrifugation and the yield are tabulated (Table I).

TABLE II

Material tested	Growth in nutrient broth	Growth on blood agar	Growth in Robertson's cooked meat medium (Anaerobic)	Remarks
Broth with 8 hour culture of <i>Escherichia coli</i>	No growth	No growth	..	Re-inoculation of the sterile media with <i>E. coli</i> produced growth, indicating no inhibiting agent was responsible for absence of growth
Sheep serum obtained from slaughter house	"	"	No growth	

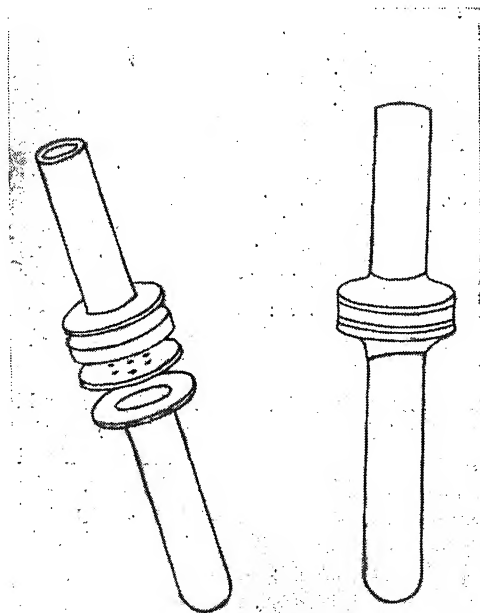


FIG. 1

the Seitz filter pad cut to that size, which is supported by a perforated stainless steel disc. The flanges are held together with a thin-walled polythene tubing (1.5 cm. diameter), which is softened by soaking in acetone for

The materials tested and the results obtained are tabulated in Table II.

Indian Hides and S. DIVAKARAN.  
Skins Improvement Society, S. H. HASAN.  
Central Leather  
Research Institute,  
Adyar, Madras-20, April 8, 1968.

#### DINOFLAGELLATE AND HYSTRICHOSPHAERID FOSSILS FROM KATROL (UPPER JURASSIC) SEDIMENTS OF KUTCH, W. INDIA

THE present note deals with Dinoflagellate and Hystrichosphaerid fossils recovered from the Katrol sediments (Upper Jurassic) of Kutch, Gujarat, India. The material is buff-coloured shale exposed on the southern side of the Pur river, one mile west of Rudar Mata temple. The exposure numbered as B.S.I.P. 900 is 89 feet thick. 30 samples were collected and 20 yielded palynological fossils. Out of these only two samples (5.8 and 5.11) contain Dinoflagellate and Hystrichosphaerid remains besides spores and pollen.

The maceration technique adopted is essentially the same as that described by Venkatachala and Kar (1967).<sup>1</sup> 23 dispersed spore-pollen genera comprising 61 species are present in the material. *Cyathidites* Couper, 1953; *Con-*

*cavissimisporites* (Delcourt and Sprumont) Delcourt, Dettmann and Hughes, 1963; *Lycopodiacidites* (Couper) Potonié, 1956; *Klukisporites* Couper, 1958; *Boseisporites* (Dev) Singh, Srivastava and Roy, 1964; *Contignisporites* Dettmann, 1963; *Applanopsis* Doering, 1961; *Podocarpidites* Cookson ex Couper, 1953; *Laricoidites* Potonié, Thomson and Thiergart, 1950 and *Araucariacites* Cookson, 1947 are common in the assemblage.

#### SYSTEMATIC DESCRIPTION

Class .. Dinoflagellate  
Family .. Gonyaulacidae  
Lindemann  
Genus .. *Gonyaulax* Diesing, 1866

*Gonyaulax jurassica* Deflandre, 1938  
(Figs. 1-2)

*Holotype*.—Deflandre, 1938; Pl. 6, Fig. 2.

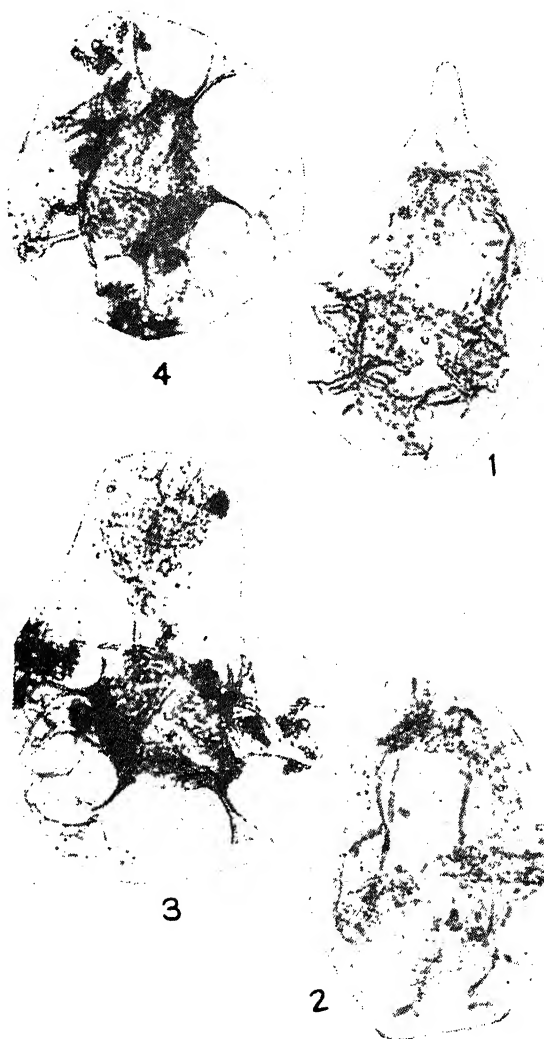
*Description*.—Microplankton, oval-elliptical in shape with a horn-like process at apical end. Size range  $75-100 \times 50-80 \mu$ . Intercalaries plate 3 on each side,  $\pm$  rhomboidal in shape, middle one generally ruptures to form the opening. Precingular plates not clearly discernible. Plates margin weakly dentate and slightly raised to provide a collar-like structure. In some well-preserved specimens two bifurcate processes are also observed at anterior apical ends.

*Remarks*.—Similar specimens have also been recorded by Deflandre (1938)<sup>2</sup> from the Jurassic of Calvados; Downie (1957)<sup>3</sup> from the Kimmeridge Clay (Jurassic); Cookson and Eisenack (1958)<sup>4</sup> from the Upper Mesozoic sediments of Australia and New Guinea; Lantz (1958)<sup>5</sup> from the Mesozoic sediments of Dorset; Klement (1960)<sup>6</sup> from the Jurassic sediments of South-West Germany, Sarjeant (1960, 1961 and 1962)<sup>7-9</sup> from the Jurassic sediments of England.

Order .. Hystrichosphæridea  
Family .. Hystrichosphæridiaceæ  
Evitt, 1963  
Genus .. *Hystrichosphæridium*  
Deflandre, 1937  
(Figs. 3-4)

*Hystrichosphæridium æmulum* Deflandre, 1938

*Description*.—Microplankton, oval-elliptical, size range (without process)  $40-60 \times 30-50 \mu$ . Processes, 8-12, mostly ramifying at ends,  $20-35 \mu$  long; space between processes granulose, grana  $\pm 1 \mu$  in size, closely placed, evenly distributed.



FIGS. 1-4. Figs. 1-2. *Gonyaulax jurassica* Deflandre, ca.  $\times 500$ . Figs. 3-4. *Hystrichosphæridium æmulum* Deflandre, ca.  $\times 500$ .

*Remarks*.—Similar specimens have also been recorded by Deflandre (1938, 1963)<sup>10</sup> from the Jurassic sediments of Villers—Sur-Mer (Calvados).

Birbal Sahni Institute of Botany, Lucknow, March 19, 1968.

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1. Venkatachala, B. S. and Kar, R. K. *Curr. Sci.*, 1967, **36** (22), 613.
2. Deflandre, G., *Trav. Stat. Zool.*, Wimerenr, 1938, **13**, 147.
3. Downie, C., *Geol. Soc. London Quart. J.*, 1954, **103**, 413.
4. Cookson, I. C. and Eisenack, A., *Proc. R. Soc. Victoria*, 1958, **70**, 19.
5. Lantz, J., *Inst. Franc. Petrole.*, 1958, **13** (6), 917.
6. Klement, K. W., *Palaeontographica*, Ser. A, 1960, **114**, 1.
7. Sarjeant, W. A. S., *Proc. York. Geol. Soc.*, 1960, **32** (4), 389.
8. —, *Palaeontology*, 1961, **4** (1), 90.
9. —, *Micropalaeontology*, 1962, **8** (2), 255.
10. Deflandre, G., *Bull. Biolog.*, 1963, **69**, 213.

# INFLUENCE OF PHYSICAL FACTORS ON THE GROWTH AND ENZYME PRODUCTION IN *TRICHODERMA VIRIDAE*, *ASPERGILLUS NIGER* AND *RHIZOPUS* SP.

PURE strains of *Trichoderma viridae* strain B-6, *Aspergillus niger* and *Rhizopus* sp. isolated from single spore culture and maintained in Czapek's agar medium for routine work were induced to grow on starch-free wheat-bran, crushed to 60 mesh, as the carbon source. The agar was excluded from the medium and the wheat-bran was moistened with the nutrient solution. In spite of the supply of the required amounts of organic nitrogen and sucrose the mycelial growth and also the spore formation were feeble at the initial stage, but in course of subcultures their inability to utilise polysaccharides in the wheat-bran was compensated and a fine growth was recorded. Gradually, in steps, organic nitrogen and sucrose were withdrawn but this did not inhibit the rate of growth.

A batch of 10 days old culture was subjected to X-ray irradiation ranging from 1,000 r to 8,000 r. Higher mycelial growth was induced in the strain receiving 2,000 r which gradually increased with higher doses reaching a peak at 6,000 r followed by a decline beyond that. A second batch was exposed to UV irradiation from 10 to 80 minutes. A somewhat similar result was obtained, the highest growth being induced with 60 minutes exposure. The X-ray induced strains were subjected to different doses of UV irradiation from 40 to 60 minutes

and the UV induced ones received 3,000 to 6,000 r. All the possible combinations within the ranges were tried. The highest mycelial growth occurred in the strain receiving 6,000 r followed by 40 minutes UV exposure.

Tubes inoculated with the controls, and the X-ray-UV irradiated strains were exposed to different intensity of illumination ranging from 0 to 2,500 lux and for variable periods in a day. Most of the spores did not germinate in the dark, and 2 to 3 small patches only of 1 to 2 mm. diameter appeared in a tube. The controls were a little more active. The rate of growth improved with the intensity of illumination, and in both the cases highest mycelial growth was recorded in those continuously exposed to 2,400 to 2,500 lux. The thickness of the mycelial cushion in the irradiated strain was double to that in the controls.

The induced *T. viridae* strain behaved in a different way. The high mycelial growth was associated with considerable suppression of spore formation and depigmentation of spores. In the control strain B-6 a uniform layer of dark green spores appeared on the third day of incubation, while in the induced strain the process was delayed to the fifth day and the spores were light green in colour. Counting of spores in spore suspension prepared in an identical way established that the number of spores in the induced strain was about 50% to that in the control.

Two sets of bulk culture were prepared with each of the control and the strain irradiated with 6,000 r/UV 40 minutes under a continuous exposure to 2,500 lux. One set received a continuous supply of moist organism-free air, bubbled through sterile 0.02 N sulphuric acid and distilled water and passed through a glass bulb packed with cotton wool, at the rate of 2 litres per hour from an air compressor. The highest concentration of the enzyme in the culture was on the sixth and the seventh day in the control and the irradiated strain respectively following which the enzyme began to level off. The enzyme was extracted on the seventh day for 2 hours at 4° with sterile distilled water, 5 vol./wt. of the substrate, centrifuged at 20,000 g. for 30 minutes at 0° and precipitated with acetone at -10°. Partially purified enzyme obtained with three successive extraction and precipitation was used for assay at 1% concentration in sodium-acetate buffer pH 5.0. The activity was compared with that of "Cellulase Onazuka P500" and "Macerozyme" (M/s. Kinki Yakult Mfg. Co.,



Japan), and "Cellase 1000" (M/s. Wallestein and Co., U.S.A.).

The cellulolytic activity of the 1% enzyme solution<sup>1,2</sup> was measured by the amount of reducing sugar<sup>3</sup> produced with the hydrolysis of carboxymethylcellulose in the form of "Cellofas B", degree of substitution about 0.5, and cellulose flock (Carl. Schleicher and Schüll) at 0.5% concentration at 40°. Controls were run with denatured enzyme solution. The reaction was terminated by bringing down the pH to 1.8 with the addition of sufficient quantity of 0.2N sulphuric acid. The results are expressed after correction for the control (Table I).

TABLE I

Reducing sugar mg. per ml. produced with the hydrolysis of soluble and insoluble celluloses by 1% partially purified enzyme solution

Enzyme source	Treatment	CMC	CMC	CMC	C.F.*
		1% (6 hr.)	4% (6 hr.)	4% (24 hr.)	
<i>T. viride</i> B-6 (control)	aerated	2.52	6.86	8.14	2.45
	non-aerated	1.9	6.2	7.2	1.6
<i>T. viride</i> B-6 (irradiated)	aerated	1.8	3.9	6.0	1.0
	non-aerated	1.4	2.3	5.4	0.74
<i>A. niger</i> (control)	aerated	2.16	5.15	5.45	0.84
<i>Rhizopus</i> (control)	aerated	2.56	4.8	5.12	2.01
Onazuka P500	..	0.15	4.8	5.4	Nil
Macerozyme	..	Nil	3.8	4.8	Nil
Cellase 1000	..	0.6	5.16	6.6	0.8

(\*) C.F. = Cellulose flock.

I wish to thank Prof. J. L. Bhaduri and Prof. P. N. Nandi, Calcutta, for their interest, Prof. N. Toyama, Japan, for supply of "Cellulase Onazuka P 500" and "Macerozyme" and M/s. Wallestein and Co., U.S.A., for "Cellase 1000", and Sri D. P. Haldar and Sri A. K. Biswas for their assistance.

Department of Zoology, K. C. GHOSE.  
Calcutta University,  
Calcutta-19, March 11, 1968.

1. Toyama, N., *Recent Advances in Enzymic Hydrolysis of Cellulose and Related Materials* (Reese, Ed.), Pergamon Press, London, 1963.
2. —, Fujii, N. and Ogawa, K., *J. Ferm. Tech.*, 1965, **43**, 756.
3. Somogyi, M., *J. Biol. Chem.*, 1945, **160**, 61.

## ON THE SPAWNING SEASON AND JUVENILES OF OIL SARDINE

PRA BHU AND DHULKHED<sup>1</sup> draw attention to earlier studies that the spawning season of *Sardinella longiceps* Val. extends from June to October or beyond. Without concrete evidence, they assume the season to extend to November-December.

Evidence of the spawning season of any fish can be obtained from eggs collected from the environment (surface water, midwater or bottom) in which the species spawns and/or from collection of prolarvæ from plankton, supported by occurrence of mature adults during that period and by studies on eggs in maturing females. However, determination of maturity and spawning season on the basis of maturity stages is subject to considerable personal bias, apart from the fact that mature adults may not occur in commercial catches or in samples investigated. There are no records of planktonic eggs and prolarvæ of oil sardine. In fact, we have little information on spawning seasons and grounds of the important marine fishes of India.

The record of juvenile oil sardines in the Mangalore zone by Prabhu and Dhulkhed does not support their assumption that the spawning season extends from June to November-December. If their assumption was correct, the juveniles with a modal length of 92 mm. in August are at least nine months old (because they are believed to be products of the previous spawning season and could not have been born later than the previous November-December), and juveniles with the same modal length occurring in October cannot be more than five months old (because they are believed to be products of the spawning season beginning in June).

If the assumption was valid, it would not be possible to explain why eggs spawned in November-December take nine months to grow to 92 mm. whereas eggs spawned in June take only five months or less to grow to the same length; it would lead to the further assumption that progeny spawned at different periods of an extended spawning season have significantly different rates of growth.

Again, the authors state that samples with modes at 92 and 112 mm. during October 1961 indicate that the fishery is supported by juveniles belonging to more than one "age

class" (*sic*). According to their assumption, juveniles with a modal length of 92 mm. have taken not more than five months to attain that size, whereas juveniles with a modal length of 112 mm. (a difference of only 20 mm. between the two modes) have taken at least ten months to attain that size. These cannot be explained away as arising from variation in environmental conditions. The occurrence of juveniles of specific lengths during particular months does not *ipso facto* warrant the assumption of the spawning season.

It is possible that the different modes in each monthly sample in some years represent different broods of an extended spawning season. Thus the polygon for August 1966 shows modes at 72, 82, 112 and 122 mm.; these modes may represent different broods of one spawning season.

Department of Zoology,  
A.U. Postgraduate Centre,  
Guntur-5, February 22, 1968.

S. DUTT.

1. Prabhu, M. S. and Dhulkhed, M. H., *Curr. Sci.*, 1967, **36** (15), 410.

DR. DUTT's doubts seem to centre round two points, *viz.*, (1) whether there is justification to believe that the spawning season of oil sardine extends up to November-December and (2) whether the progeny of oil sardine spawned at different periods have different rates of growth. Regarding point 1, Dr. Dutt himself seems to realise that there is no authentic direct evidence at present to define the spawning period of oil sardine, in view of which circumstantial evidence has necessarily to be relied upon. It may also be added that our assumption was based on observations made during a number of years on the occurrence of juveniles, mature and spent fish in various stages and also the progression of modes. With regard to point 2, it is quite probable that progeny spawned at different periods may have different rates of growth in view of the significant environmental variations recognised during the monsoon, pre-monsoon and post-monsoon months.

Central Marine Fisheries  
Research Unit, Bolar,  
Mangalore-1, April 29, 1968.

M. S. PRABHU.

# YELLOW SEEDED MUTATIONS IN BRASSICA JUNCEA HOOK. f. AND THOMS. INDUCED BY RADIOACTIVE SULPHUR—<sup>35</sup>S\*

X-RAY induced useful mutants have been reported<sup>1,2</sup> in *B. juncea* var. *Rai 5* and their breeding value has been evaluated<sup>3</sup> earlier. Similar studies have also been carried out with radioactive isotopes, such as phosphorus (<sup>32</sup>P) and sulphur (<sup>35</sup>S). The present communication reports two yellow seeded mutants isolated from *B. juncea* var. *Rai 5* (West Bengal) after treatment with radioactive sulphur—<sup>35</sup>S. The cultivated *Rai 5* variety possesses blackish-brown seeds.

The seeds of *Rai 5* were treated with three initial activities, *i.e.*, 9.76  $\mu$ c, 14.65  $\mu$ c and 24.41  $\mu$ c of radioactive sulphur—<sup>35</sup>S per seed for 24, 48 and 72 hours durations. One hundred seeds were treated for each dose and duration and the same number of seeds were soaked in distilled water. The seeds after soaking in the radioactive solution and water for the specified period were thoroughly washed in running water and were then sown in lines 30 cm. apart giving a spacing of 15 cm. between plants, putting one seed per hill. Ten plants having good growth were selected from each treatment and control from the  $M_1$  population and they were harvested individually. All the plants in  $M_1$  generation yielded blackish-brown seeds. The progeny of each selection was raised as separate line during the following season.

The  $M_2$  population was affected by aphids (*Lipaphis erysimi* Kalt.) at the time of flowering and the yield was poor. Ten plants which appeared to be best in field observation were harvested from each treatment and dry and wet controls. Two selections, *viz.*, R11/97 and R33/25 from 24.41  $\mu$ c/24 hours and 14.65  $\mu$ c/48 hours treatments respectively gave yellow seeds instead of blackish-brown seeds of the parent. The number of fruits in the former selection was 27 with 0.06 gm. seeds and in the latter 73 with 0.30 gm. seeds. Majority of seeds in both selections were ill-developed, shrunken and appeared to be sterile.

In the  $M_3$  generation during the following season only one plant in selection R11/97 and five plants in selection R33/25 survived and they had yellow seeds; these are designated as yellow-seeded mutant 1—"YSM<sub>1</sub>" and yellow-seeded mutant 2—"YSM<sub>2</sub>" respectively

TABLE I  
Showing the salient features of yellow sarson (*B. campestris*), Rai 5 (*B. juncea*) and the radiation induced mutants

Variety	Leaf	Pods	Seed	Seedcoat	Chromosome number (2n)
Yellow sarson ( <i>B. campestris</i> )	Auicled and stem clasping, glaucous, fleshy	Thick and broad	Big, slimy in water	Yellow and smooth	20
Rai 5 ( <i>B. juncea</i> )	Petioled and hairy	Thin and narrow, torulose	Small, non- slimy in water	Blackish-brown and reticulate	36
YSM <sub>1</sub>	"	"	"	Yellow and reticu- late	36
YSM <sub>2</sub>	"	"	"	"	36

(Fig. 1). The mutants bred true during subsequent generations.

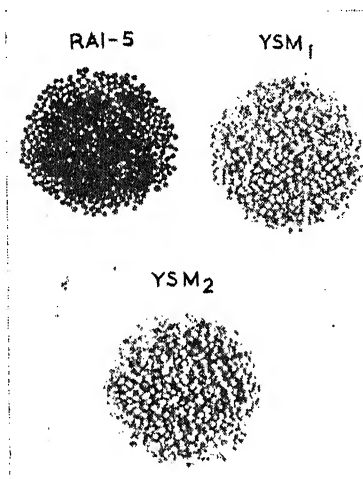


FIG. 1. Seed colour differences in Rai 5 and the mutants, YSM<sub>1</sub> and YSM<sub>2</sub>.

Some cultivated varieties of *B. campestris* L. possess yellow seeds and they are classified as yellow sarson and yellow toria. But, so far the author has no information about varieties of *B. juncea* possessing yellow seeds. *B. campestris* and *B. juncea* are distinct species and have characteristic differences. The salient features of yellow sarson, Rai 5 and the yellow seeded mutants are given in Table I.

Estimation of oil content has revealed that YSM<sub>2</sub> yielded about 3% more oil than its parent. Preliminary studies have shown that yellow seed colour is recessive to blackish-brown.

The author expresses his sincere gratitude to Dr. K. T. Jacob for his help during the progress of this work. He is also thankful to Dr. D. M. Bose for giving all facilities. His

thanks are also due to the Indian Central Oilseeds Committee for financing a scheme under which the work was carried out.

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March 22, 1968.

\* This work was done at Bose Institute, Calcutta.

1. Rai, U. K., *Sci. and Cult.*, 1958, **24**, 46.
2. —, *Ibid.*, 1959, **24**, 534.
3. — and Nayar, G. G., *Ind. Oilseeds Jour.*, 1959, **3**, 237.

#### TAXONOMIC NOTES ON SOME SPECIES OF *BLASTUS* LOUR. (MELASTOMATACEAE)

LOUREIRO (in *Fl. Cochinch.*, 526, 1790) established the genus *Blastus* on the basis of *Blastus cochinchinensis* Lour., a glandulose shrub having tetramerous flowers with dorsally and ventrally inappendiculate stamens from Indo-China. For nearly a century this genus was known only by the type species until Cogniaux (1891) described *Blastus borneensis* Cogn. from Borneo on the basis of Teysmann s.n. The type of *Blastus borneensis* has not been seen by the author, but from Cogniaux's description it appears to be conspecific with *Blastus cogniauxii* Stapf.

So far about 23 species are known of which 20 are confined to S. China and N. Vietnam. *B. cochinchinensis* Lour. and *B. cogniauxii* Stapf are the two widely spread species. The former extends from N.-E. India, S. China, Vietnam to Formosa and to Japan; whereas the latter ranges from Malaya, Sumatra, Borneo, Celebes to Vietnam and Hainan.

Diels (1932) proposed two sections: (i) *Desmoblastus* on the basis of the possession of axillary inflorescences and white flowers typified by *B. cochinchinensis*, and (ii) sect.

*Thyrsoblastus* for species having terminal inflorescence and rose or purple flowers. Though Li (1944) followed Diels he doubted the classification based on the position of inflorescence and the colour of flowers. It is seen that this classification breaks down as in *B. glandulosus* Spare and *B. cogniauxii* Stapf the inflorescence is both terminal and axillary; while in *B. pulverulentus* Ridl. the inflorescence is subterminal. Certain notes and new combinations are given below:

1. *Blastus pulverulentus* Ridl. in *Journ. Linn. Soc.*, 1913, 41, 290; Ridley, *Fl. Mal. Pen.*, 1922, 1, 774. (Type: C. B. Kloss s.n. K):

*Blastus tomentosus* Bakh. f. in *Meded. Bot. Mus. and Herb. Rijks Univ. Utrecht*, 1943, No. 91, 276. (Type: van Steenis 6283, Holotype L, isotype K). *Synon. nov.*

**Distribution:** Malaya: Selangor, Ulu Langat, C. B. Kloss s.n. (K); Sumatra: Atjeh, Boernilintang, alt. 1800 m., van Steenis 6283 (K, L).

Bakhuizen f.'s species *B. tomentosus* from Sumatra perfectly matches *B. pulverulentus* Ridl. from Malaya and hence it is proposed to reduce *B. tomentosus* Bakh. f. to a synonym of *B. pulverulentus* Ridl.

2. *Blastus lii* Nayar nom. nov.

*Blastus tomentosus* Li in *Journ. Arn. Arb.*, 1944, 25, 18, non-Bakh. f.

**Distribution:** China: Kwangsi, Wailsap Dist., Tong Shan, near Sap-luk Po village, W. T. Tsang (Type A).

Li's specific epithet 'tomentosus' is preoccupied by Bakh.f.'s (1943) species *B. tomentosus* based on van Steenis 6283. *Blastus lii* is allied to *B. pulverulentus* Ridl., but differs in having larger inflorescence and longer capsule.

3. *Blastus cogniauxii* Stapf in Hook.f.,  *Ic. Pl.*, 1894, 24, t. 2311; Guillaum. in *Bull. Soc. Bot. France*, 1913, 60, 90; Guillaum. in Lecomte, *Fl. Gen. Indo-Chine*, 1921, 2, 1896; Schwartz in *Mitt. Inst. Bot. Hamburg*, 1931, Bd. 7, 238; Merrill in *Papers Michigan Acad. Sc.*, 1934, 20, 105; Bakh. f. in *Meded. Bot. Mus. and Herb. Rijks. Univ. Utrecht*, 1943, No. 9, 275; Li in *Journ. Arn. Arb.*, 1944, 25, 16; *Ochthocharis parviflora* Cogn. in DC., *Monogr. Phan.*, 1891, 7, 481. (Type: Beccari 1403, isotype K.).

**Additional material:** Borneo: Sabah, Mt. Kinabalu, alt. 1333 m., 29 July 1961, R.S.N.B. No. 1194(K); *Ibid.*, alt. 600 m., 7 June 1961,

R.S.N.B. No. 504(K); *Ibid.*, Dallas, alt. 1000 m., 21 December 1931, J. and M.S. Clemens 27064(K); *Ibid.*, above Silam Basin, 18 May 1932, J. and M.S. Clemens 30285(K); Vietnam: Mt. Bani, J. and M.S. Clemens 4033(K).

Stapf (1894) appropriately transferred *Ochthocharis parviflora* Cogn. to the genus *Blastus*. Since the specific epithet 'parviflora' was preoccupied in *Blastus* by Triana's *B. parviflorus*, Stapf proposed a new name *B. cogniauxii*. Bakh. f. (1943) doubted whether Stapf had examined the type specimen Beccari 1403 while making the nomenclature changes. At Kew the isotype Beccari 1403 is available.

4. *Blastus cogniauxii* Stapf var. *caudatus* (G. H. Spare) Nayar comb. et stat. nov. *Blastus caudatus* G. H. Spare in *Kew Bull.*, 319 (1929). (Type: Kings Collector 553, K).

**Distribution:** Malaya: Perak, Goping, King's Collector 553(K); Selangor, Bukit Tuku, Ridley 7304(K); Pahang, Kuala Lipis, Machado 11587(K); Telom, Ridley 13549; Ulu Kuantan, Symington and Kiah 28918(K); Johore, Kota Tinggi-Mawai Road, Corner 29304(K); Ulu Segun, Gunong Panti, Corner 30655(K).

Spare differentiated this taxon on the basis of its caudate-acuminate leaves, acute buds and caudate-acuminate petals. On careful scrutiny of Malayan and Bornean specimens, it is seen that there is a great deal of variation from acuminate to caudate-acuminate condition and the only stable feature noticed in the Malayan specimens are the caudate-acuminate petals. Since in all other features *B. caudatus* agrees with that of *B. cogniauxii*, it is proposed to reduce this taxon to a variety of *B. cogniauxii*.

I wish to express my gratitude to Sir George Taylor, Director, Royal Botanic Gardens, Kew, for all facilities, and Rev. Fr. H. Santapau and Dr. K. Subramanyam for their encouragement.

Industrial Section,  
Indian Museum,  
Botanical Survey of India,  
Calcutta-13, April 9, 1968.

M. P. NAYAR.

1. Bakhuizen van den Brink, R. C., Jr., *Meded. Bot. Mus. & Herb. Rijks. Univ. Utrecht*, 1943, 91, 30.
2. Cogniaux, A., *De Candolle, Monogr. Phan. (Melastomaceae)*, 1891, 7, 477.
3. Diels, L., *Bot. Jahrb.*, 1932, 65, 104.
4. Li, H. L., *Jour. Arn. Arb.*, 1944, 25, 14.
5. Stapf, O., *Hook. f., Ic. Pl.*, 1894, 24, t. 2311.

# IN VITRO CULTURE OF BAMBOO EMBRYOS

*Bambusa* and *Saccharum* cross easily but the two genera are isolated by post-fertilization barriers. The most important among these barriers is hybrid inviability (Rao *et al.*, 1967) which could be overcome by resorting to embryo culture. As a first step towards this, the growth requirements of bamboo embryo in artificial nutrient media were standardised and the details are given in this report.

Mature bamboo embryos were aseptically removed from the endosperm and cultured in artificial medium containing Whites major and minor elements and sucrose. Four concentrations of sucrose (0.5, 1.0, 2.0 and 3%) were tried along with the control containing no sucrose. Difco bacterio agar (1%) was melted; other ingredients added; pH adjusted to 5.6; 15 ml. of the medium poured into the culture tubes; tubes plugged with cotton plugs and autoclaved at 15 lb. for 15 mts. After preparing the slants embryos were surface sterilised and implanted five per culture tube. The cultures were kept at  $76 \pm 1^\circ \text{F}$ . under a 12 hr. photoperiod. Weekly observations were recorded on the growth of the epicotyl and hypocotyl.

In all the treatments the embryo germinated within a period of 3-5 days. The growth of the embryos in the different concentrations is shown in Fig. 1. In the absence of sucrose the

of the increased number of internodes, but on account of increased length of the internode. From the data it appears that the optimum amount of sucrose required for the growth of the embryo is 2%.

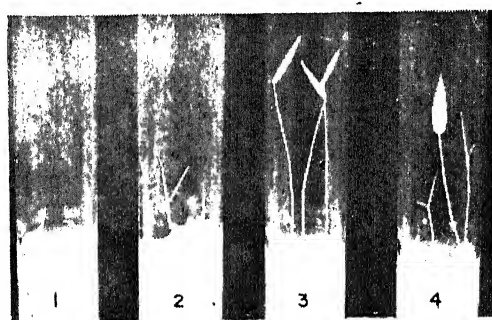
TABLE I

Average length of the main shoot measured 15 days after implantation in nutrient media

Concentration of sucrose	Length of shoot in cm.
Control (0%)	0.5
0.5%	0.8
1.0%	1.25
2.0%	4.66
3.0%	3.6

In embryo culture the role of carbohydrate in the first instance is nutritional and secondly it adjusts the osmotic pressure of the medium equal to that of cell sap. Optimum concentration depends upon the maturity of the embryo and upon the species under consideration. In literature there are many references to the sugar requirements of embryos in artificial media. Haggen-Smith *et al.* (1945) and Sanders and Lieber (1950) used 5% and 4% sucrose respectively for culturing young embryos of corn and *Datura*. Raghavan and Torrey (1963) cultured immature embryos of *Datura*, *Hordeum* and *Capsella* in media containing 2% sucrose and other growth factors. Simple medium consisting of major and minor elements along with sucrose is satisfactory for mature embryos. Boharmont (1961) tried different concentrations of sucrose for mature embryos of rice and found 2% sucrose to be optimum for satisfactory growth. In the absence of sucrose he found retarded growth for the epicotyl and hypocotyl. The first leaf also did not emerge out of the coleoptile. In the present study also it was observed that mature embryos of bamboo grew satisfactorily in a medium containing 2% sucrose and major and minor elements. In the absence of sucrose even though the embryos germinated their growth was not satisfactory.

Sugarcane Breeding Inst., M. P. ALEXANDER.  
Coimbatore-7, T. C. RAMANA RAO.  
April 17, 1968.



FIGS. 1-4. Growth of bamboo embryo in different concentrations of sucrose. Fig. 1. 0.5% sucrose. Fig. 2. 1.0% sucrose. Fig. 3. 2.0% sucrose. Fig. 4. 3.0% sucrose.

growth of the hypocotyl and epicotyl was retarded. In the control and in 0.5% sucrose the first leaf did not open out of the coleoptile. The length of the main shoot 15 days after implantation is given in Table I.

From the data it could be seen that in 2% sucrose, maximum growth of the main shoot was obtained. In this case the increase in the length of the main shoot was not on account

1. Boharmont, J., *Euphytica*, 1961, **10**, 283.
2. Haggen-Smith, A. J., Siu, R. and Wilson, G., *Science*, 1945, **101**, 234.
3. Raghavan, V. and Torrey, U. G., *Amer. J. Bot.*, 1963, **56**, 546.
4. Rao, J. T., Alexander, M. P. and Kandaswami, P. A., *J. Ind. Bot. Soc.*, 1966, **46**, 199.
5. Sanders, Mary, E. and Lieber, N. K., *Recent Advances in Embryology of Angiosperms*, Ed.: Maheshwari, P., 1963, p. 297.

ACANTHACEAE<sup>1</sup>I. Accessories in *Justicia gendarussa*

DURING the course of our programme of investigation of chromosomal basis of evolution in Acanthaceae the presence of accessory chromosomes was observed in *Justicia gendarussa*. The chromosome number of this species has been found to be  $2n=30$ . This is a new number for genus *Justicia*, the other species have  $2n=18$  (*J. quinqueangularis*<sup>1</sup>),  $2n=28$  (*J. debilis* and *J. furcata*<sup>6</sup>) and  $2n=32$  (*J. coccinea*<sup>7</sup>). The accessories were present in 6 out of 50 cells studied. Among the A-chromosomes a bivalent is distinctly larger than the rest. The B-chromosomes are very small and heterochromatic. When present their number has been found to be always two (Fig. 1) but they never paired to form a

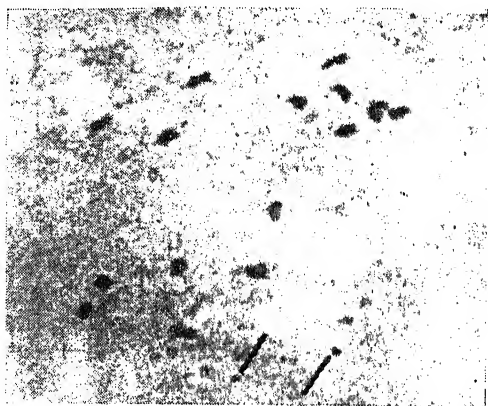


FIG. 1. A PMC showing 15 bivalents and two dot-shaped B-chromosomes.

bivalent. This is in sharp contrast to behaviour of a pair of accessories, reported from this laboratory in *Impatiense balsamina*<sup>5</sup> which were indistinguishable morphologically and in behaviour from A-chromosomes and they invariably paired to form a bivalent which behaved normally. Such nature of accessories indicate their recent origin from the normal chromosomal complement. Generally accessories are smaller than the normal chromosomes, their number varies from plant to plant, from tissue to tissue or even in different cells of the same tissue. They do not pair with A-chromosomes but may pair among themselves. They are heterochromatic and generally do not have any marked phenotypic effect on the individuals possessing them. The accessories in *Justicia* appear to possess most of these characteristics and are similar to those reported in *Trigonella*

*foenum-graecum*.<sup>3-4</sup> However, in the present case they are so small that they appear almost round and no distinct centromere could be identified. But they are oriented on the metaphase plate along with the rest of chromosomes. Accessories could arise in natural populations through chromosomal aberrations<sup>2</sup> or when a new species arises through a change from a higher to a lower chromosome number. Accessories may arise then as by-product.<sup>8</sup> Most of the species of *Justicia* reported so far have a chromosome number lower than *J. gendarussa* except *J. coccinea*, which has  $2n=32$ . The relationship of *J. gendarussa* and *J. coccinea* as indicated by their chromosomal studies may be interesting from this point of view.

Cytogenetics Lab., SATENDRA S. RAGHUVANSHI.  
Botany Department, SNEH L. RASTOGI.  
Lucknow University,  
Lucknow, April 25, 1968.

1. Ahuja, M. R. and Natarajan, A. T., *Curr. Sci.*, 1957, 26 (4), 117.
2. Darlington, C. D., *Chromosome Botany*, London, Allen and Unwin, 1950.
3. Joshi, Sheila and Raghuvanshi, S. S., *Phyton*, 1967, 12, 278.
4. Raghuvanshi, S. S. and Sheila Joshi, *Curr. Sci.*, 1964, 33 (21), 654.
5. — and —, *Genetica*, 1968 (In press).
6. Sugiura, T., *Proc. Imp. Acad.*, 1936, 12, 144.
7. Takizawa, Y., *Cytologia*, 1957, 22 (2), 116.
8. Virkii, N., *Ann. Acad. Sci. Fenn. Ser. A. IV, Biol.*, 1954, 26, 1.

### UROHENDERSONIA PONGAMIAE SP. NOV.

An interesting fungus was observed on living leaves of *Pongamia pinnata* Merr. which carried infection from *Phyllachora pongamiae* (Berk. and Br.) P. Henn. The fungus was found in leaf spots surrounding the phyllachorid fructifications of the ascomycete. These leaf spots were irregular to angular and measured up to 1.5 cm. in diameter.

The morphological features of the fungus agree with those of the genus *Urohendersonia* described by Spegazzini in 1902. *U. platensis* Speg. is the type of the genus. A comparison has been made with Spegazzini's original diagnosis of the species. Type specimen of the second species in the genus, *U. indica* Syd., obtained from Herb. Crypt. Ind. Orient., New Delhi, has been examined. Our studies show that our collection on *Pongamia* differs from the two species mentioned above, in the morphology and dimensions of pycnidia,

conidia and the conidial appendage. The appendages in many of the mature spores totally disappear, in which condition the fungus could be mistaken for a *Hendersonia*.

*Urohendersonia pongamiae* NAG RAJ AND  
PONNAPPA SP. NOV. (FIG. 1)

Fungus foliicolus, consociatus cum maculis foliaribus, cingentibus stroma phyllachoræ pongamiæ, irregularibus vel angularibus, una vel multis in quoque folio. Maculæ contiguæ

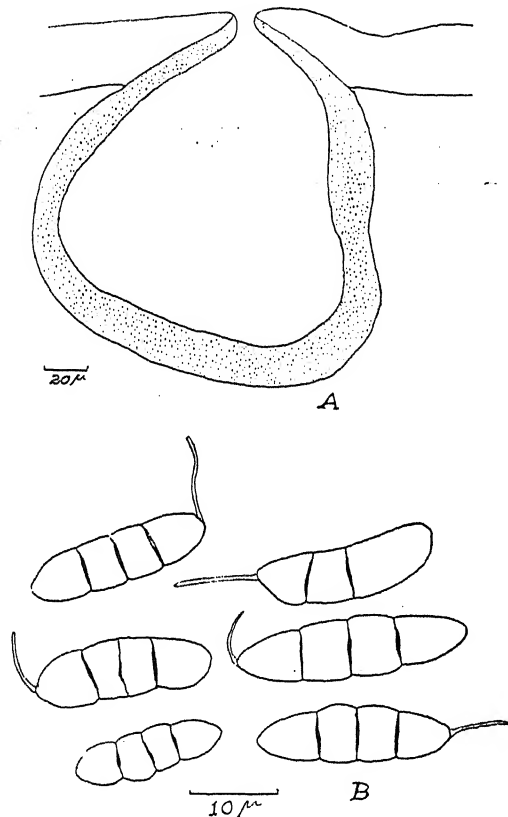


FIG. 1. *Urohendersonia pongamiae*. A. Pycnidia and B. Conidia.

coalescentes et maculas amplas formantes, brunneolas in media parte, margine brunnea bene definita. Pycnidia epiphylla, sæpe amphigena, solitaria vel gregaria et confluentia, subepidermalia, initio immersa, postea innata erumpentia, globosa vel depressa et globosa, ostiolata, brunneola vel brunnea, 107.0-194.50 × 97.25-194.50 µ pariete pseudo-parenchymato; conidiophora hyalina, continua, pariete tenui, globosa vel ovalia; conidia elliptica vel oblongato-elliptica vel elliptico-fusiformia, 3-septata aliquando formibus

2-septatis, constricta ad septam, brunnea vel umbrina, 15.80-22.50 × 5.50-7.50 (19.25 × 5.5) µ, appendicem unicam, gracilem, hyalinam, filiformem, sæpe evanescentem 10.25 - 13.0 µ longam ferentia.

Habitat folia viventia *Pongamiae pinnatae*. 8. VIII. 1967. Hebbal Farm, Bangalore (Mysore State). K. M. Ponnappa. Fungus consociatus cum *Phyllachora pongamiae* (Berk. et Br.) P. Henn. Herb. IMI 130733 (typus).

*Urohendersonia pongamiae* Sp. Nov.

Foliicolous, associated with leaf spots. Leaf spots, surrounding the stroma of *Phyllachora pongamiae*, irregular to angular, one to many per leaf, adjacent spots tending to coalesce to form large patches, light brown in the middle part with a well-defined dark brown margin. Pycnidia epiphyllous, frequently amphigenous, solitary to gregarious and confluent, subepidermal, at first immersed, later innate erumpent, globose to depressed-globose, ostiolate, pale brown to brown, 107.0-194.50 × 97.25-194.50 µ with a pseudoparenchymatous wall; conidiophores hyaline, continuous, thin-walled, globose or oval; conidia elliptic, oblong-elliptical or fusiform-elliptical, 3-septate with occasional 2-septate forms, constricted at the septa, truncate to round at base and obtuse at the apex, brown to dark brown, 15.80-22.50 × 5.50-7.50 (19.25 × 5.5) µ bearing a single, slender, hyaline, filiform, often evanescent, 10.25-13.0 µ long appendage.

Hab.: On living leaves of *Pongamia pinnata* Merr., August 8, 1967. Hebbal Farm, Bangalore (Mysore State), K. M. Ponnappa. In association with *Phyllachora pongamiae* (Berk. and Br.) P. Henn. Type in Herb. IMI 130733, England.

The true nature of the association between the two fungi has not been examined by us. The ascospores present in the stroma of *Phyllachora* appeared to be viable in spite of the association of *Urohendersonia pongamiae*. This suggests that the latter is a secondary invader of the host tissue inflicting little damage on *Phyllachora pongamiae*.

We are grateful to Dr. V. P. Rao, for his keen interest, and to Mr. P. Basu for furnishing the Latin translation of the new species.

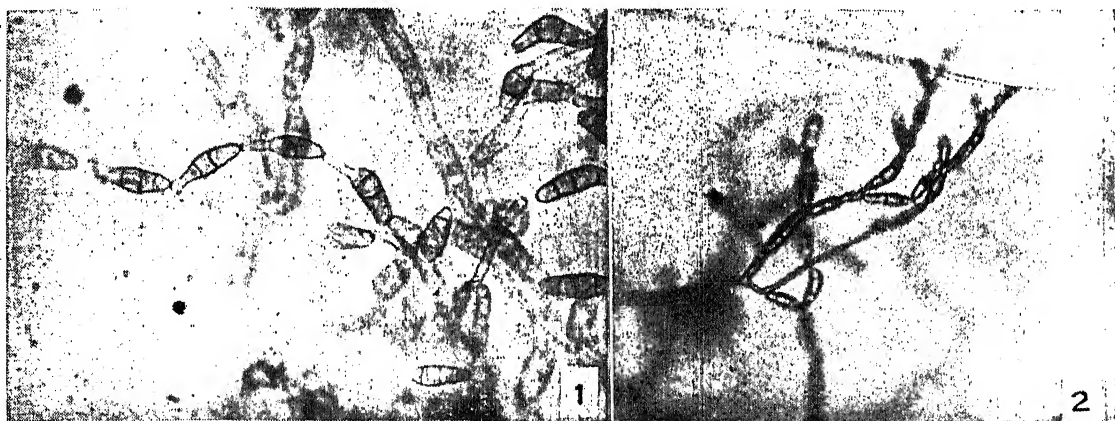
Commonwealth Institute of T. R. NAG RAJ.\*  
Biological Control, K. M. PONNAPPA.  
Indian Station,  
Bangalore-6 (India), April 15, 1968.

\* Present address: Department of Biology, University of Waterloo, Waterloo, Ont., Canada.



A NEW SPECIES OF *CURVULARIA*

DURING a regular survey of leaf spot diseases the authors observed severe leaf spots on *Lagerstroemia indica* L. and *Mimusops elangi* L. Isolations from such spots yielded an unusual species of *Curvularia*. This species is characterized by formation of profuse chain of conidia on culture medium. The conidial morphology of the isolate differed from all the known species of this genus.<sup>1-9</sup> The culture was sent to C.M.I., Kew, where it was examined by Dr. Ellis who regards it as an undescribed species of *Curvularia*. This species, therefore, is being described and designated as *Curvularia catenulata* spec. nov. having the following morphological characters:



FIGS. 1-2. Fig. 1. Photomicrograph showing conidia in chains,  $\times 1,120$ . Fig. 2. Photomicrograph showing conidia in branched chains,  $\times 441$ .

Colonies spreading on P.D.A.; hyphae submerged or aerial, light-brown, closely septate, often constricted at the septum,  $2.7-5.2 \mu$  wide; conidiophores simple arising from the hyphae singly or in groups, slightly bulged at the base, gradually narrowing towards the tip,  $81.8-163.6 \times 2.7-4.5 \mu$ ; conidia borne in chains of 3-10 (Fig. 1), chains often branched (Fig. 2), 3-5-celled, slightly curved, fusiform or clavate with a prominent papillae at the tip, light-brown, 3rd cell from the base usually larger and darker, basal cell with a protruding dark-brown hilum,  $24.1 \times 5.6$  ( $16.36-38.1 \times 5.45-10.9 \mu$ ).

Isolated from the leaves of *Lagerstroemia indica*, culture deposited in C.M.I., Kew (No. 129295).

Coloniae in cultura in agar potato-dextrose effusae. Mycelium partim superficiale partim in substrato immersum ex hyphis pallide

brunneis, arte septatis, saepe ad septa constrictis,  $2.6-5.2 \mu$  crassis. Conidiophora solitaria vel fasciculata ex hyphis oriunda, basi leviter inflata, apicem versus gradatim attenuata,  $81.8-163.6 \times 2.7-5.4 \mu$ . Conidia 3-10-catenulata, catenis saepe ramosis, 2-4-septata, leviter curvata, fusiformia vel clavata, apice papilla prominenti praedita, pallide brunnea, cellula tertia plerumque ampliore et fuscior, cellula basalis hilo protrudenti atrobrunneo praedita,  $24.1 \times 5.6$  ( $16.36-38.1 \times 5.45-10.9 \mu$ ).

Ex foliis *Lagerstroemiae indicae*, India, S. M. Reddy et K. S. Bilgrami, IMI 129295 typus.

The authors are grateful to Dr. G. C. Ainsworth, Director, C.M.I., Kew and Dr. M. B.

Ellis for their opinion on the culture. In addition Dr. Ellis rendered Latin diagnosis which is gratefully acknowledged.

Department of Botany,  
University of Jodhpur,  
India, April 11, 1968.

S. M. REDDY.  
K. S. BILGRAMI.

1. Boedijn, K. B., *Bull. Jard. Bot. Buttanz.*, 1933, **13**, 120.
2. Ellis, M. B., *Mycol. Paper*, 1966, No. **106**.
3. Jain, B. L., *Trans. Brit. Mycol. Soc.*, 1962, **45**, 539.
4. Mathur, R. L. and Mathur, B. L., *Curr. Sci.*, 1959, **28**, 448.
5. Parmelee, J. A., *Mycologia*, 1956, **48**, 558.
6. Rao, P. N. and Salam, M. A., *J. Indian bot. Soc.*, 1954, **34**, 208.
7. Srivastava, H. P. and Bilgrami, K. S., *Proc. Natl. Acad. Sci.*, 1963, **33**, 208.
8. Subramanian, C. V., *Proc. Ind. Acad. Sci.*, 1953, **38B**, 27.
9. Tandon, R. N. and Bilgrami, K. S., *Curr. Sci.*, 1962, **31**, 254.



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## REVIEWS AND NOTICES OF BOOKS

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An Anharmonic Crystal. By Philippe F. Choquard. (W. A. Benjamin, Inc., 1 Park Avenue, New York, New York 10016), 1967. Pp. 352. Price \$5.95 Paper; \$10.00 Cloth.

In February 1964, at the invitation of Professor J. Bardeen, the author gave a series of seminar lectures entitled "Selected Topics in Lattice Dynamics" at the University of Illinois. This research monograph, which grew out of these lectures, covers a molecular field theory of the equilibrium properties of anharmonic crystals. Chapters 1 to 4 and a part of Chapter 6 deal with the classical aspect of the theory; the remainder treats most of its quantum theoretical counterpart.

Although the monograph is addressed primarily to theoreticians, the inclusion of a section dealing with thermal properties makes it valuable to experimentalists as well. It may also be used as a main text for advanced level graduate courses in lattice dynamics, and as a supplement for courses in solid-state physics.

C. V. R.

Film-Forming Compositions, Part I, Volume I of *Treatise on Coatings*. Edited by R. R. Myers and J. S. Long. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y.), 1967. Pp. xx+564. Price \$35.00 for single copy; \$28.00, for subscribers to entire treatise. Note: A 20% discount is given on each volume or part to subscribers of entire treatise.

For more than twenty years there has not appeared in the United States a treatise of more than two volumes concerning the raw materials and finished products of the coatings industry. In this age of rapid change and development, this treatise is timely and necessary. Carrying forward the work begun by Mattiello, this multivolume set is designed to furnish a comprehensive coverage of the facets of the coatings industry today. The two editors hold the titles of former and present Director of the Paint Research Institute.

New types of coatings, particularly protective coatings; new raw materials and intermediates; new forms and techniques of application and curing; as well as new instruments, tools, equipment, and chemicals, are some of the areas covered. This treatise will be of service

to chemists, formulators, laboratory assistants, technicians, and production superintendents of the coatings industry. It is also valuable for laboratory personnel of the raw material suppliers, chemists in the plastics and similar industries, and is a good reference treatise for libraries.

C. V. R.

Nuclear Reactor Materials. By Professor Charles O. Smith. (Addison-Wesley Publishing Co., Inc., 10-15, Chitty Street, London W. 1), 1967. Pp. viii+262. Price \$13.50.

Intended for a materials course in nuclear engineering, this book is designed to give an in-depth survey of materials requirements and usage in nuclear reactors.

Content areas include the role and requirements of materials in nuclear reactors, materials in fuel elements and liquid-fuel reactors, effects of nuclear radiation, characteristics of specific materials (such as uranium, plutonium, thorium, structural metals, ceramics, and graphite), and materials development. An important feature of the book, intended to serve those just beginning to become involved with reactors, is the logical development of the role of materials in reactors. Helpful problems and exercises are provided for most of the chapters in the book.

C. V. R.

Progress in Mathematics (Vol. 2)—*Mathematical Analysis*. Edited by R. V. Gamkrelidze. (Translated from Russian). (Plenum Press, New York), 1968. Pp. 161. Price \$15.00.

This volume consists of two review articles. The first article on "The Theory and Methods of Investigation of Branch Points of Solutions" by M. M. Vainberg and P. G. Aizengendler describes results concerning methods of obtaining solutions of non-linear differential equations, integral equations and integro-differential equations depending on parameters. The second article on "Imbedding and Continuation for Classes of Differentiable Functions of Several Variables Defined in the Whole Space" by V. I. Burenkov reviews results of recent Soviet contributions on the topic published between 1961 and 1965. Each article cites extensive literature on the topics concerned.

A. S. G.

**Problems and Solutions in General Physics.**

By Simon G. G. MacDonald. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W. 1, England), 1967. Pp. 276. Price 25 sh.

The author has included in this book more than 300 carefully thought-out problems with their detailed solutions so as to cover the whole range of physics at somophore level. The problems on fundamental laws of motion, gravity and mechanics have been oriented to meet the developments in space science. Many old problems have been cleverly re-constructed to brighten up the reading, e.g., problem 38.2.

The book is in three sections. The main section of about 200 pages contains 327 problems with the solution given under each problem. The problems are arranged in 50 classified subject titles. The second section contains about a hundred miscellaneous selected problems with their solutions grouped at the end of the section. The third section again contains a hundred supplementary problems for which only the answers are given. The book will no doubt be useful to students of science and engineering to supplement their class lectures and gain a more thorough understanding of the fundamentals of physics.

A. S. G.

**Engineering Mechanics (Vol. 2)—Dynamics.**

By T. C. Huang. (Addison-Wesley Publishing House, Inc., West End House, 11, Hills Place, London W. 1, England), 1967. Pp. 397-860. Price \$7.95.

This is the companion volume to the one on *Statics* by the author. It is a junior level text-book useful to teachers and students of engineering mechanics. In addition to text matter each chapter contains a large number of examples and problems.

A. S. G.

**Elementary Calculus.** By G. Hadley. (Holden-Day, Inc., 500, Sansome Street, San Francisco, U.S.A.), 1968. Pp. 421. Price \$10.75.

At the present time a knowledge of elementary calculus has become a necessity in fields of study, other than mathematics, science and engineering—such as social sciences, business economics, biology and medicine. The present book is aimed at providing a one-semester course for this broad group of students. The text includes chapters on arithmetic, algebra, analytical geometry, limits and differentiation, integration, numerical analysis, and functions of several variables.

A. S. G.

**ANNOUNCEMENTS****Award of Research Degrees**

The Maharaja Sayajirao University of Baroda, has awarded the Ph.D. degree to the following, on subjects noted against each:

Shri Badrinarayan Bhailalbhair Thakar (Physics); Shri Venkataramana Bhat (Chemistry); Shri Kiran Mukundrai Desai (Zoology); Shri Surinder Singh Jaimal Singh Bedi (Botany).

Osmania University has awarded the Ph.D. degree in Geology to Shri P. V. Somayajulu.

**Institution of Chemists (India)—Associateship Examination (1969)**

The Nineteenth Associateship Examination of the Institution of Chemists (India) will be held in November 1969. The last date for Registration is 30th November, 1968. The Examination is recognised by the Government of India as equivalent to M.Sc. in Chemistry for purposes of recruitment of Chemists.

Further enquiries regarding this and for Membership may be made to the Honorary Secretary, Institution of Chemists (India), Chemical Department, Medical College, Calcutta-12.

**Books Received**

**A petrography of Australian Metamorphic Rocks.** By G. A. Joplin. (Angus and Robertson Ltd., 221, George St., Sydney), 1968. Pp. x + 262. Price \$8.00.

**Real Analysis: An Introduction.** By A. J. White. (Addison-Wesley Publishing Co., Inc., London W. 1, England), 1968. Pp. vii + 244. Price: 38 sh. (Paper Edition); 55 sh. (Bound Edition).

**An Introduction to Masers and Lasers.** By T. P. Melia. (Chapman and Hall Ltd., 11, New Fetter Lane, London EC. 4), 1967. Pp. xiv + 162. Price 35 sh.

**Layered Igneous Rock.** By L. R. Wager and G. M. Brown. (Oliver and Boyd, Tweedle Court, Edinburgh-1), 1967. Pp. xv + 588. Price £8-8 sh.

**Eye Movements and Vision.** By A. L. Yarbus. (Plenum Publishing Corporation, New York 10011), 1967. Pp. xiii + 222. Price not given.

**Quaternary Extinctions of Large Mammals.** By D. I. Axelrod. (University of California Press, South 10th Street, Richmand, California 94804), 1967. Pp. v + 42. Price \$1.50.

**Chemical Principles in Practice.** Edited by J. A. Bell. (Addison-Wesley Publishing Co., Inc., London W. 1, England), 1967. Pp. xi + 273. Price 27 sh.

# CARBONYL COMPOUNDS AS POSSIBLE CAUSE OF ODOUR IN VEGETABLE OILS

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THE presence of odour in vegetable oils has been known for a long time. In order to remove undesirable odour, steam distillation and vacuum heating have been recommended. But comparatively little work has been done on the isolation and characterisation of the chemical components responsible for odour. A search into the literature reveals that the main interest has been on the odour components of butter and of the strongly smelling mustard oil and the related Cruciferae oils. However, some work has been done on the volatile components of palm kernel<sup>1</sup> and cocoanut oil.<sup>2,3</sup> The former is reported to contain methyl nonyl ketone; oil from fresh cocoanut contains mainly  $\delta$ -lactones having the characteristic cocoanut odour. The crude cocoanut oil where some microbiological decomposition had set in, contains also ketones with odd number of carbon atoms.

In the course of our investigation on the non-fatty components of minor oil-seeds and oils, it was noticed that many of them have marked odour and colour. Nahor oil is one such having a dark brown colour and a strong unpleasant odour. It is obtained from the seed kernel of *Mesua ferrea*. When the oil was subjected to steam distillation, the distillate had the characteristic smell and gave 2,4-dinitrophenyl hydrazone (DNPH). Ether extraction of the distillate failed since the extracted components were highly volatile and escaped with ether. A better method was to pass the steam distillate directly into an alc. HCl solution of 2,4-dinitrophenyl hydrazine. The product was a mixture that could be separated into a major ether soluble fraction which contained two components identified as DNPH's of acetaldehyde and *n*-hexaldehyde along with some other component which has not been identified. The ether insoluble fraction after further purification was identified as glyoxal DNPH. Thus nahor seed oil contains as steam volatile components acetaldehyde, *n*-hexaldehyde and glyoxal. Nahor oil obtained from a second sample of *Mesua ferrea* seed kernel yielded only acetaldehyde.

The main experimental details with sample (I) are given below:

(a) Nahor seed oil (50 g.) obtained by extracting the seed kernel with petroleum ether was subjected to steam distillation for about 8 hr. and the steam distillate extracted with ether in a continuous extractor and the ether extract concentrated. No residue was left. The aqueous solution left after ether extraction was treated with excess of alc. HCl solution of 2,4-dinitrophenyl hydrazine and the solution kept overnight. The yellow bulky ppt. of DNPH was filtered, dried, dissolved in benzene and passed through a column of silica gel. The column was washed with benzene, the benzene solution evaporated and DNPH crystallised from alcohol; 160–63°;  $\lambda_{\text{max}}$  428 m $\mu$  in aq. methanolic potash<sup>4</sup>; m.wt (Rast) 205. (Found: C, 42.9; H, 3.8; N, 25.1;  $\text{C}_8\text{H}_8\text{N}_4\text{O}_4$  requires C, 42.8; H, 3.5; N, 25.0.) Its identity as acetaldehyde DNPH was confirmed by comparison with an authentic sample prepared from acetaldehyde.

(b) Nahor oil (23 g.) was subjected to steam distillation for about 10 hr. and the steam distillate directly passed into an alc. HCl solution of 2,4-dinitrophenyl hydrazine at ordinary temperature. The solution was kept overnight and the DNPH formed was filtered and dried. On tlc. using silica gel and ethyl acetate-benzene (1 : 19), it was found to be a mixture of six components with three of  $R_f$  values 0.86, 0.75 and 0.40 in comparatively larger proportion. It was treated with ether and the ether solution evaporated to dryness. The residue was dissolved in benzene, passed through a column of silica gel and eluted with benzene. Different fractions in 4 c.c. lots were collected. Tlc. examination of the first two fractions indicated them to be rich in the compound having  $R_f$  value 0.86. The solvent was removed and the residue obtained was repeatedly crystallised from alcohol, m.p. 98–100°. Its properties agreed with those of *n*-hexaldehyde DNPH and the identity was confirmed by comparison with an authentic sample using  $R_f$  value and I.R. spectrum; mixed m.p. was undepressed. The later eluates

yielded acetaldehyde DNPH ( $R_f$  0.75) already described. The ether insoluble portion of DNPH ( $R_f$  0.40) was first washed with a little alcohol to remove excess of reagent. The residue thus obtained crystallised from nitro-benzene as scarlet needles, m.p. over  $300^\circ$ . (Found: C, 40.6; H, 2.7; N, 26.5;  $C_{14}H_{10}N_8O_8$  requires C, 40.0; H, 2.3; N, 26.7.) Its identity as glyoxal DNPH was confirmed by comparison with an authentic sample using chromatography and I.R. spectrum. Glyoxal required for comparison was prepared by the hydrolysis of dichloro dioxane.<sup>5</sup>

Bisulphite extraction was also possible. A sample of the oil was dissolved in ether and extracted with a saturated solution of sodium bisulphite repeatedly. The bisulphite extract was decomposed with hydrochloric acid, and treated with alc. HCl solution of 2,4-dinitrophenyl hydrazine. The product could be fractionated in the same way as mentioned above and all the three DNPH's were obtained. The residual ether solution on evaporation yielded the oil free from odour.

In continuation of the above work we had occasion to test a few other minor oils. Pongamia oil has also smell though it is not so unpleasant as that of nahor seed oil. In this case also steam distillation and bisulphite extraction removed the carbonyl compounds and they have been identified as acetone and glyoxal. Essential details are given below:

Pongamia oil was subjected to steam distillation and DNPH was collected as described in the case of nahor oil. It was fractionated

into ether soluble and ether insoluble portions. The former was passed through a column of silica gel and crystallised from alcohol; m.p.  $121-23^\circ$ . Its identity as acetone DNPH was confirmed by comparison with an authentic sample using co-chromatography and m.m.p. The ether insoluble portion of DNPH was washed with a little alcohol and crystallised from nitrobenzene yielding scarlet needles, m.p. over  $300^\circ$ ;  $\lambda_{max}$  580 m $\mu$  in aq. methanolic potash.<sup>4</sup> (Found C, 40.4; H, 2.8; N, 27.0;  $C_{14}H_{10}N_8O_8$  requires C, 40.0; H, 2.3; N, 26.7.) Its identity as glyoxal DNPH was confirmed by comparison with an authentic sample.<sup>5</sup>

Neem oil is notorious for its markedly unpleasant odour. Steam distillation however removes most of the odour. The DNPH from the oil steam distillate was collected as in the above cases, and fractionated into ether soluble and ether insoluble portions. The former was a mixture of 4 DNPH's which have not been identified; but its spectrum is characteristic of mono-DNPH. The ether insoluble fraction after washing with a little alcohol was repeatedly crystallised from nitrobenzene. It was identical with the DNPH of glyoxal obtained from nahor oil and also synthetically prepared.<sup>5</sup> In the bisulphite extract of the oil only glyoxal could be obtained.

1. Salway, A. H., *J. Chem. Soc.*, 1917, **111**, 407.
2. Allen, R. K., *Chem. and Ind.*, 1965, p. 1560.
3. Gehrig, R. F. and Knight, S. G., *Appl. Microbiol.*, 1963, **11**, 166.
4. Wells, C. F., *Tetrahedron*, 1966, **22**, 2685.
5. Böseken, Tellegen and Henriques, *Proc. Roy. Soc. Amsterdam*, 1931, **34**, 631.

## URANIUM DISEQUILIBRIUM IN ARABIAN SEA

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SINCE the discovery of high  $U^{234}/U^{238}$  activity ratios in natural waters percolating through uranium ore beds by Russian workers,<sup>1</sup> the attention of many scientists<sup>2-5</sup> has been directed towards the disequilibrium studies of uranium in other natural materials. The disequilibrium of uranium in nature is significant since this anomaly may be used as a geochemical tool in the study of rocks, soils and natural waters. The first encouraging results of Thurber,<sup>2</sup> on Einwetok corals which gave a value of  $1.17 \pm$

$0.03$  for the  $U^{234}/U^{238}$  activity ratio, accelerated the work by other workers<sup>6-8</sup> in looking for uranium isotopic composition in sea-waters, shells and marine carbonates. Most of the sea-water studies are confined to the Pacific and the Atlantic Oceans and the accepted value for these waters is  $1.15 \pm 0.02$ . Recently Veeh<sup>9</sup> has determined the  $U^{234}/U^{238}$  ratio in Red Sea and reported also the same value. There is no data on Indian Ocean waters, especially on coastal waters. It is the objective

of the present investigation to determine the uranium isotopic ratio in waters, quite near the coast, off West Coast of India, and to see whether any difference exists between these values and those obtained by other workers in the open and coastal waters.

Four sea-water samples, about 40 litres each (1 mile off shore), are collected along with two shell samples from the beach of Tarapur. The sea-water samples are filtered through Whatman No. 42 into polyethylene carboys and about 150 ml. of concentrated HCl is added while stirring and kept for 2 hours. 500 mg. of iron solution is added and precipitated as hydroxide to carry down uranium. The solution is filtered and the precipitate preserved. On determining the uranium fluorimetrically in the hydroxide precipitate and the original sea-water, it has been found that only 40-50% of the total uranium is carried along with a single hydroxide precipitate. In order to get higher recovery values the above procedure is repeated three more times adding 500 mg. of iron each time. The hydroxide precipitates are mixed and dissolved in dilute nitric acid and boiled for sufficient time to precipitate silica. The solution is cooled and silica is removed by centrifugation. The clear solution is oxidised with potassium bromate and reduced in volume to 30-40 ml. and acidity adjusted to 1N. About 40-50 gm. of solid aluminium nitrate (1 gm. per ml. of solution) is added and uranium extracted with an equal volume of ethyl acetate (BDH A.R.). The organic phase containing uranium is destroyed with concentrated nitric acid and evaporated to dryness. The residue is taken up in 8N HCl and passed through Dowex 1 anion exchange resin which was previously conditioned with 8N HCl. The column is thoroughly washed with 8N HCl and uranium along with  $\text{Fe}^{\text{III}}$  and traces of  $\text{Pa}^{\text{V}}$  and  $\text{Po}^{\text{VI}}$  is leached with 0.5N HCl. The leach solution is evaporated to dryness and dissolved in 20 ml. of 6-8N HCl. The solution is extracted with an equal volume of methyl iso-butyl ketone (BDH A.R.) when  $\text{Fe}^{\text{III}}$ ,  $\text{Pa}^{\text{V}}$  and  $\text{Po}^{\text{VI}}$  are extracted into organic phase leaving behind uranium in the aqueous phase. The aqueous phase is separated and the organic layer is back-extracted 4 more times with 6N HCl to remove uranium completely. The aqueous phase and the back extracts are mixed and evaporated to dryness. The residue is radiochemically pure uranium. The shell samples are dissolved in ammonium acetate-acetic acid buffer of pH 5, filtered and

the filtrate is subjected to the above purification steps.

The residue is taken up in 5 ml. of 0.5N nitric acid and transferred into a 1" diameter electroplating unit. 5 ml. of saturated ammonium oxalate is added. The cathode is a 1" diameter stainless steel disc (buffed). The anode is a platinum gauze. A current of 1-1.5 amp. is passed for about 2 hours. The stainless steel disc containing uranium is then warmed over a flame for about 5 to 10 minutes to remove traces of organic matter. The sample is counted with ORTEC 1 cm. surface barrier detector, coupled to a ORTEC low noise pre-amplifier unit. The spectra is recorded in a Nuclear data 512 channel analyser.

The overall chemical recovery of the procedure is tested for three samples using 20 gm. calcium carbonate (free from uranium) and adding known amounts of uranium. The recoveries are  $90 \pm 5\%$ . The plating efficiency is separately determined using standards and it is found to be almost 100% within statistical errors when above-mentioned conditions are satisfied. The total uranium content of the samples is separately estimated by fluorimetric analysis.

The location of the water and shell samples analysed are given in Table I along with uranium isotopic ratios. As seen from Table I, the  $\text{U}^{234}/\text{U}^{238}$  ratio from Bombay and Tarapur sea-waters are giving values close to  $1.16 \pm 0.03$ , whereas the shell samples are giving slightly different values of  $1.20 \pm 0.03$  and  $1.11 \pm 0.04$ . In Figs. 1, 2 and 3 are given the alpha spectra of two of the water samples analysed along with a standard uranium sample for comparison. Uranium standard (Fig. 3) shows two distinct peaks of  $\text{U}^{235}$  whereas the spectra of the samples show no such distinction.

Even though the water samples are from coastal region, the observed average value of  $1.16 \pm 0.03$  is not different from open ocean values as reported in the literature for the Pacific and Atlantic Oceans. This suggests that the input of uranium from land drainage into coastal waters is not significant to affect any isotopic differences between coastal and open ocean waters. Large differences in the isotopic ratios of uranium in other natural waters have been reported in the literature<sup>1,10</sup> and the observed variations in the  $\text{U}^{234}/\text{U}^{238}$  ratios in the shell samples can be largely attributed to the environmental changes in

TABLE I

 $U^{234}/U^{238}$  activity ratios in sea-water and shells

No.	Sample	Location		Date of collection	Uranium content ppm	$U^{234}/U^{238}$
		Lat. °N	Long. °E			
SW-1	Sea water	..	19° 48' 72° 38' (Tarapur)	October 1966	$2.7 \times 10^{-5}$	$1.15 \pm 0.02$
SW-2	do.	..	19° 48' 72° 38' (Tarapur)	November 1967	$2.7 \times 10^{-5}$	$1.17 \pm 0.03$
SW-3	do.	..	18° 50' 72° 35' (Bombay)	April 1968	$3.0 \times 10^{-5}$	$1.18 \pm 0.04$
SW-4	do.	..	18° 50' 72° 45' (Bombay)	June 1968	$3.0 \times 10^{-5}$	$1.15 \pm 0.03$
SH-1	<i>Astrea semicostata</i> sp. (shell)	..	19° 48' 72° 38' (Tarapur)	October 1967	0.34	$1.20 \pm 0.02$
SH-2	<i>Nerita</i> sp. (shell)	..	19° 48' 72° 38' (Tarapur)	October 1967	0.14	$1.11 \pm 0.04$

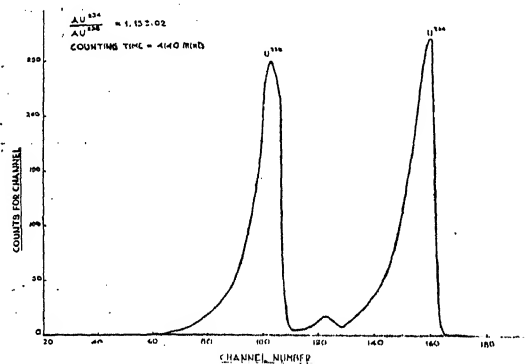


FIG. 1 Sea-water from Tarapur (SW-1).

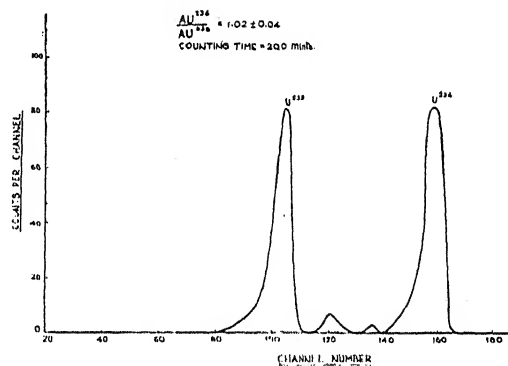


FIG. 3. Uranium standard.

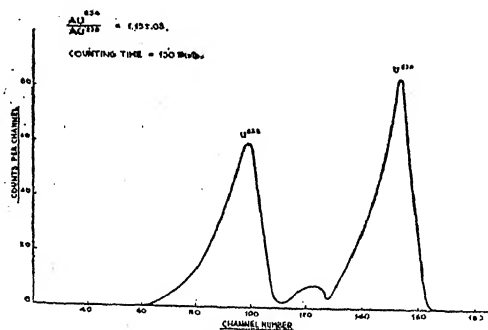


FIG. 2 Sea-water from Bombay Harbour (SW-4)

which they are grown. The observed disequilibrium of uranium in the shells and sea-water open up the possibility of determining the sedimentation rate in coastal regions which contain high calcium carbonate along with a good amount of shell material.

We wish to express our appreciation to Dr. A. K. Ganguly, Head, Health Physics Division, Bhabha Atomic Research Centre, for the encouragement given to us during the investigation.

1. Isabaev, E. A., Usatov, E. P. and Cherdyntsev, V. V., *Radiochim.*, 1960, 2, 94.
2. Thurber, D. L., *Jour. Geophys. Res.*, 1962, 67, 4518.
3. Moore, W. S. and Sackett, W. M., *Ibid.*, 1964, 69, 5401.
4. Teh-lung Ku, *Ibid.*, 1965, 70, 3457.
5. Blanchard, R. L., Cheng, M. H. and Potratz, H. A., *Ibid.*, 1967, 72, 4745.
6. Broecker, W. S. and Thurber, D. L., *Science*, 1965, 149, 58.
7. Koide, M. and Goldberg, E. D., *Progress in Oceanography*, Pergamon Press, New York, 1965, 3, 173.
8. Veeh, H. H., *Jour. Geophys. Res.*, 1966, 71, 3379.
9. —, *Geochim. Cosmochim. Acta*, 1968, 32, 117.
10. Blanchard, R. L., *Jour. Geophys. Res.*, 1965, 70, 4056.

## RESPONSE OF YOUNG INFLORESCENCES OF *ANETHUM GRAVEOLENS* L. TO GROWTH SUBSTANCES

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THE inflorescence of *Anethum graveolens* contains potentially hermaphrodite, male and underdeveloped coral buds (see Sehgal).<sup>1</sup> Young inflorescences (6 mm.  $\times$  1.25 mm.) were surface-sterilized with chlorine water for 4-6 min., thoroughly washed in sterile, distilled water, and cultured under aseptic conditions on modified White's medium (WM) containing 4% sucrose. The medium was jelled with 0.8% Difco bacto-agar and supplemented variously with adenine (Ad), casein hydrolysate (CH), coconut milk (CM), indoleacetic acid (IAA), kinetin (Kn), yeast extract (YE), and 2,4-dichlorophenoxyacetic acid (2,4-D). The pH of the medium was adjusted to 5.8, and 15 ml. of the medium was dispensed in each culture tube. The medium was autoclaved at 15 lb./sq. inch for 15 min. The cultures were maintained in diffuse daylight, at a temperature of  $25 \pm 2^\circ \text{C}$ . and  $55 \pm 5\%$  RH. For each experiment 72 cultures were raised and the experiments were repeated once.

At the time of culturing, the inflorescences bore floral buds at stages ranging from a convex protuberance (without the differentiation of floral organs) to buds showing primordia of corolla, androecium and gynoecium. On WM the inflorescences shrivelled within 2 weeks. On WM + IAA (0.5, 1.0 ppm.) the inflorescence axis as well as the pedicels of flowers callused within 3 weeks. The growth of callus was slow and in another 2 weeks a number of roots differentiated from it (Fig. 1, A, B). In the above medium only 5-10 floral buds developed into hermaphrodite flowers (Fig. 1, B) as compared to nearly 400 such flowers in nature. However, even these finally collapsed due to lack of cross-pollination and fertilization.

On WM + CM (10%) the inflorescence axis as well as pedicels of flowers produced brownish-white fluffy mass of friable callus within 3 weeks. Addition of 2,4-D (1 ppm.) to the above medium improved growth of the callus, and it was successfully subcultured. Profuse callusing was obtained on WM + CH (500 ppm.) + 2,4-D (0.5 ppm.) + Kn (0.5 ppm.). However, the callus failed to differentiate into organs when left *in situ* or on transfer to WM with or without YE (1000 ppm.). If a portion of the callus was transferred to WM +  $\text{KNO}_3$  (5 mM/1), roots

developed all over the explant in 24% cultures. When transferred to WM +  $(\text{NH}_4)_2\text{SO}_4$  (5 mM/1), numerous whitish nodules developed in 36% cultures within 2 weeks. In another week these nodules developed shoot buds (Fig. 1, C), the growth of which was slow and they did not grow beyond 1.5 cm. On WM + Ad (10 ppm.) the callus produced both roots and shoots in 56% cases, 4 weeks after subculture.

On WM + CH (500, 1000 ppm.) and WM + YE 8-14 floral buds developed into hermaphrodite flowers, while the remaining floral buds collapsed and the inflorescence axis as well as pedicels of flowers produced callus 3 weeks after culture. The callus showed slow growth and in another week produced several embryoids (Fig. 1, D). The ontogeny of the embryoids did not conform to any of the conventional type of embryogeny,<sup>2</sup> but the globular and heart-shaped stages were gone through as usual. The embryoids showed 2-4 cotyledons and developed into plantlets *in situ* (Fig. 1, E).

Young floral buds of *Anagallis arvensis*,<sup>3</sup> *Viscaria candida* and *V. cardinalis*<sup>4</sup> have been successfully reared to mature flowers in cultures. However, those of *Kalanchoe pinnata*,<sup>5</sup> *Phlox drummondii*<sup>6</sup> and *Ranunculus sceleratus*<sup>7</sup> failed to do so. All the floral buds in the young inflorescences of *Anethum graveolens* (present work) did not produce hermaphrodite flowers, but it has been possible to induce differentiation of the callus derived from the inflorescence axis and the pedicel of floral buds. This was achieved by appropriate balance of growth adjuvants in the medium.

I am grateful to Professor B. M. Johri, for his valuable counsel and facilities. My thanks are also due to Dr. R. N. Chopra and Dr. N. S. Rangaswamy for going through the manuscript.

1. Sehgal, C. B., *Proc. Nat. Inst. Sci. India*, 1968, **34B**, 60.
2. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, McGraw-Hill Book Co., New York, 1950.
3. Brulfert, J. and Fontaine, D., *Biologia Pl.*, 1967, **9**, 439.
4. Blake, Jennet, *Nature*, London, 1966, **211**, 990.
5. Mohan Ram, H. Y. and Wadhi, Mridul, *Naturwissenschaften*, 1966, **53**, 558.
6. Konar, R. N. and Konar, Aparna, *Phytomorphology*, 1966, **16**, 379.
7. — and Nataraja, K., *Naturwissenschaften*, 1965, **52**, 140.



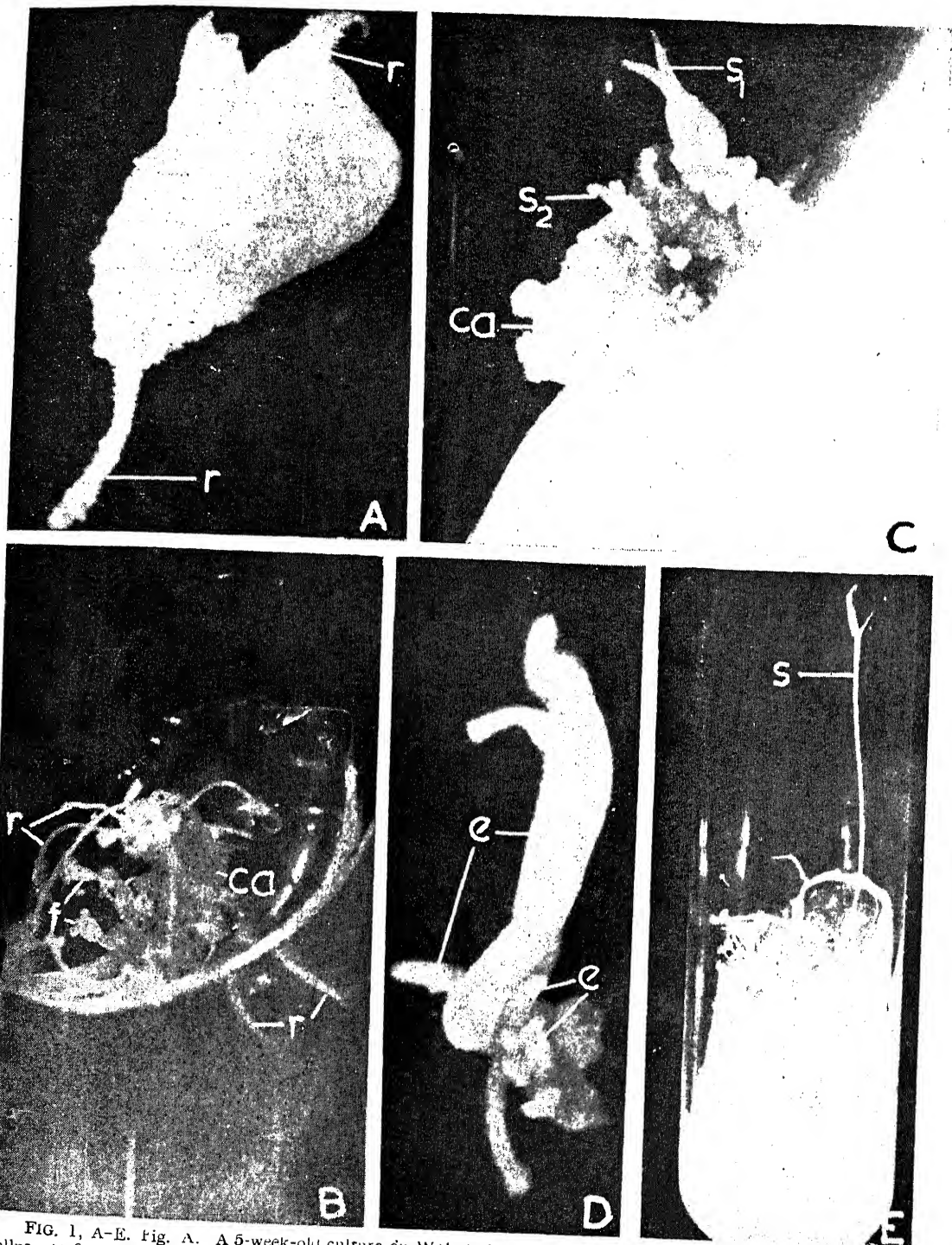


FIG. 1, A-E. Fig. A. A 5-week-old culture on WM + IAA (1 ppm.); note the presence of roots on the callus,  $\times 8$ . Fig. B. Same, 11-week-old; note profuse rooting and 5 hermaphrodite flowers (only 2 have been labelled),  $\times 2.5$ . Fig. C. A portion of callus, raised on WM + CM (10%) + 2, 4-D (0.5 ppm.) subcultured for 10 weeks on WM +  $(\text{NH}_4)_2\text{SO}_4$  (5 mM/l), showing shoot buds,  $\times 3.25$ . Fig. D. Polyembryoid mass from WM + YE (500 ppm.) showing some developmental stages,  $\times 35$ . Fig. E. 15 week-old culture on WM + YE (500 ppm.), showing normal plantlet,  $\times 1.25$ . (ca, callus; e, embryoid; f, flower; r, root; s, shoot;  $s_1, s_2$ , shoot buds).



# ON THE RAYLEIGH'S FLOW PAST AN INFINITE POROUS PLATE—I

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THE Rayleigh's problem<sup>1</sup> in fluid mechanics, i.e., the flow of a viscous incompressible fluid due to an impulsively moving plate has been examined for a rotating fluid by Chawla.<sup>2</sup> Here we consider the two-dimensional unsteady flow of a viscous incompressible fluid past an infinite porous flat plate (chosen along X-axis) at zero incidence with uniform suction  $v_0 < 0$ . The relevant equations of motion together with the initial and the boundary conditions are

$$\frac{\partial u}{\partial t} + v_0 \frac{\partial u}{\partial y} = \nu \frac{\partial^2 u}{\partial y^2}, \quad v_0 < 0. \quad (1)$$

$$\begin{aligned} t = 0: u &= 0 \quad \text{for } y = 0, \\ t > 0: u &= U_0 \quad \text{for } y = 0, \\ &< \infty \quad \text{for } y \rightarrow \infty. \end{aligned} \quad (2)$$

We introduce the non-dimensional quantities

$$\phi = \frac{u}{U_0}, \quad \eta = \frac{y U_0}{\nu}, \quad \tau = \frac{U_0^2 t}{\nu}, \quad \beta = \frac{v_0}{U_0}, \quad (3)$$

where  $\beta$  can be looked upon as the suction parameter. Then (1, 2) become

$$\frac{\partial \phi}{\partial \tau} + \beta \frac{\partial \phi}{\partial \eta} = \frac{\partial^2 \phi}{\partial \eta^2}, \quad (4)$$

$$\begin{aligned} \tau = 0: \phi &= 0 \quad \text{for } \eta = 0, \\ \tau > 0: \phi &= 1 \quad \text{for } \eta = 0, \\ &< \infty \quad \text{for } \eta \rightarrow \infty, \end{aligned} \quad (5)$$

The solution of (4) subject to (5) is

$$\phi = \frac{1}{2} \left\{ e^{\eta \beta} \operatorname{erfc} \left( \frac{\eta}{2\sqrt{\tau}} + \frac{\beta}{2\sqrt{\tau}} \right) + \operatorname{erfc} \left( \frac{\eta}{2\sqrt{\tau}} + \frac{\beta}{2\sqrt{\tau}} \right) \right\}. \quad (6)$$

The non-dimensional skin friction  $\Gamma$  defined by  $-(d\phi/d\eta)_{\eta=0}$  becomes

$$\Gamma = \frac{1}{\sqrt{\pi \tau}} e^{-(\tau \beta^2/4)} + \frac{\beta}{2} \operatorname{erfc} \left( \frac{\beta}{2\sqrt{\tau}} \right). \quad (7)$$

The steady state corresponds to  $\tau \rightarrow \infty$ ; in this case  $\phi$  and  $\Gamma$  are given by

$$\phi_{st} = e^{\eta \beta}, \quad \Gamma_{st} = \beta. \quad (8)$$

Tables I and II give the calculated values of  $\phi$  and  $\Gamma$  given by (6, 7) for  $\beta = 0, 1, 2$ ;  $\tau = .04, .36, 1, \infty$  and  $\eta = 0(2)1$ .

# ON THE RAYLEIGH'S FLOW PAST AN INFINITE POROUS PLATE—II

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IN the previous article referred to as (I), the effect of suction on Rayleigh's flow in fluid mechanics has been considered. Equations (6) and (7) of I are the expressions for the

TABLE I  
Velocity distribution near an impulsively moving plate

$\tau \backslash \eta$	0	.2	.4	.6	.8	1
.04	0 1 .4795 .1573 .0333 .0047 .0004 1 1 .4321 .1280 .0249 .0031 .0003 2 1 .3861 .1128 .0180 .0020 .0001					
.36	0 1 .8133 .6377 .4795 .3455 .2388 1 1 .7249 .5080 .34.3 .2214 .1375 2 1 .6283 .3843 .2274 .1299 .0716					
1	0 1 .8875 .7773 .6714 .5716 .4795 1 1 .7828 .6064 .4645 .3515 .2626 2 1 .6622 .4362 .2857 .1858 .1198					
$\infty$	0 1 1 1 1 1 1 1 1 .8187 .6703 .5488 .4493 .3679 2 1 .6703 .4493 .3012 .2019 .1353					

TABLE II  
The skin friction at the plate

$\tau \backslash \beta$	0	1	2
.04	2.8210	3.3491	3.9330
.36	.9403	1.5237	2.2599
1	.5642	1.1996	2.0503
$\infty$	0	1	2

From the calculated values, we infer that (i) as  $\beta$  (corresponding to the suction velocity  $v_0$ ) increases, for a given time, the velocity at any point of the fluid decreases and the skin friction at the plate increases and (ii) for any given  $\beta$ , as the time advances, the velocity at any point of the fluid increases and the skin friction decreases. Ultimately  $\phi$  and  $\Gamma$  settle down to the steady state values corresponding to  $\tau \rightarrow \infty$ .

- Schlichting, H., *Boundary Layer Theory*, Pergamon Press, 1955, p. 64.
- Chawla, S. S., *J. Phys. Soc. Japan*, 1967, **23**, 663.

that the fluid is weakly conducting and that a uniform magnetic field  $H_0$  is applied along Y-axis perpendicular to the flow. When the magnetic lines of force are fixed relative to the fluid, the equation of motion<sup>1</sup> is

$$\frac{\partial u}{\partial \tau} = \nu \frac{\partial^2 u}{\partial y^2} - mu, \quad m = \frac{\partial \mu^2 H_0^2}{\rho} \quad (1)$$

Solving (1) subject to the initial and boundary conditions (2) of I, we obtain, in terms of the non-dimensional quantities (3) of I.

$$\frac{\partial \phi}{\partial \tau} = \frac{\partial^2 \phi}{\partial \eta^2} - \alpha^2 \phi, \quad \alpha = \frac{\nu m \nu}{U_0}, \quad (2)$$

where  $\alpha$  is looked upon as the Hartmann number in the unsteady motion. The solution of (2) is

$$\phi_M = \frac{1}{2} \left\{ e^{-\eta^\alpha} \operatorname{erfc} \left( \frac{\eta}{2\sqrt{\tau}} - \alpha\sqrt{\tau} \right) + e^{\eta^\alpha} \operatorname{erfc} \left( \frac{\eta}{2\sqrt{\tau}} + \alpha\sqrt{\tau} \right) \right\}, \quad (3)$$

$$\Gamma_M = \frac{1}{\sqrt{\pi\tau}} e^{-\alpha^2\tau} + \alpha \operatorname{erfc} \alpha\sqrt{\tau}, \quad (4)$$

as  $\tau \rightarrow \infty$ ,

$$\phi_{M, st} = e^{-\eta^\alpha}, \quad \Gamma_{M, st} = \alpha. \quad (5)$$

If the magnetic lines of force are fixed relative to the plate,<sup>2</sup> (1) is to be replaced by

$$\frac{\partial u}{\partial \tau} = \frac{\partial^2 u}{\partial y^2} - m(u - U_0). \quad (6)$$

In this case,

$$\phi_R = 1 - e^{-\alpha^2\tau} \operatorname{erfc} \frac{\eta}{2\sqrt{\tau}}, \quad (7)$$

$$\Gamma_R = \frac{e^{-\alpha^2\tau}}{\sqrt{\pi\tau}}. \quad (8)$$

As  $\tau \rightarrow \infty$ ,

$$\phi_{R, st} = 1, \quad \Gamma_{R, st} = 0. \quad (9)$$

Figure 1. shows that, for equal values of  $\alpha$  and  $\beta$ ,  $\phi_s < \phi_M < \phi_R$  for a given  $\eta$  at  $\tau = 1$ . This is found to be true, for all values of  $\tau$  ( $0 < \tau < \infty$ ). Thus the fluid velocity is retarded more by applying suction than by the magnetic field. Similarly from Fig. 2, we infer that the skin friction at the plate is more in the case of suction than in the magnetic case.

Again, a study of Fig. 1 and Fig. 2 indicates that, (1) as  $\beta$  (corresponding to the suction velocity  $v_0$ ) increases, the velocity at any point of the fluid decreases and the skin friction at the plate increases. (2) As  $\alpha$  (corresponding to the strength of the magnetic field  $H_0$ ) increases, (i) when the magnetic lines of force are fixed relative to the fluid, the velocity at any point decreases while the skin friction at the plate increases and (ii) when the magnetic lines of force are fixed relative to the plate, the velocity at any point increases while the skin friction at the plate decreases.

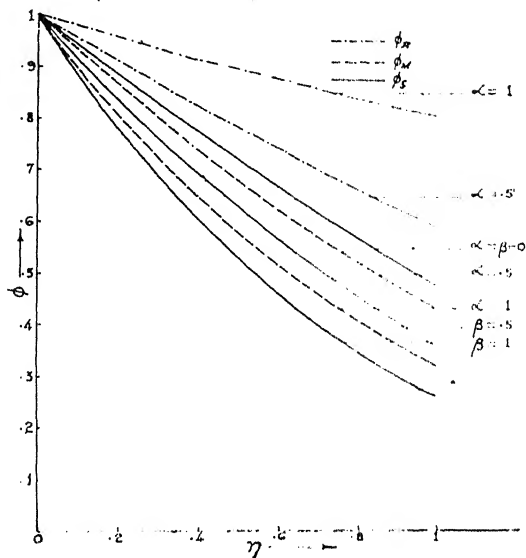


FIG. 1. Non-dimensional velocity  $\phi$  versus  $\eta$  at  $\tau = 1$  for different values of  $\alpha$  and  $\beta$ .

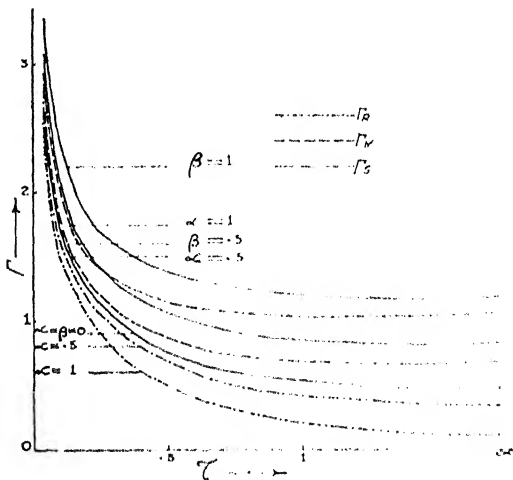


FIG. 2. Non-dimensional skin friction  $\Gamma$  versus  $\tau$  for different values of  $\alpha$  and  $\beta$ .

Also, numerical calculations of  $\phi$  for various values of  $\tau$  show that, for any given  $\alpha$  or  $\beta$ , as the time advances, the velocity at any point of the fluid in the corresponding case increases and the skin friction decreases. Ultimately  $\phi$  and  $\Gamma$  settle down respectively to their steady state values corresponding to  $\tau = \infty$ .

1. Pai, S. I., *Magnetogas Dynamics and Plasma Dynamics*, Springer-Verlag, 1962, p. 65.
2. Soundalgekar, V. M., *Appl. Sci. Res.*, 1965, 12 B, 151.

## LETTERS TO THE EDITOR

### THE EXTERNAL FIELD OF A RADIATING CHARGED PARTICLE IN GENERAL RELATIVITY

The external field of a charged particle is described by Nordström's solution. There is an electric field in the space round this charged particle. The external field of a radiating star is described by Vaidya.<sup>1</sup> In the outer space of this star there is the expanding zone of pure radiation with radius  $r_1$  at time  $t_1$  beyond which the empty space is described by Schwarzschild's exterior solution. The generalization of Nordström's solution corresponding to the external field of a radiating charged particle has not yet been obtained. In the following we report a line element describing the external field of a radiating charged particle.

The line element obtained for this field is given by

$$ds^2 = - \left( 1 - \frac{2m}{r} + \frac{e^2}{r^2} \right) dt^2 - \frac{\dot{m}^2}{f^2} \left( 1 - \frac{2m}{r} + \frac{e^2}{r^2} \right) dr^2 - r^2 d\Omega^2 \quad (1)$$

where

$$d\Omega^2 = d\theta^2 + \sin^2\theta d\phi^2$$

$$m = m(r, t)$$

$$e = \text{const.}$$

$$f = f(m) = m' \left( 1 - \frac{2m}{r} + \frac{e^2}{r^2} \right)$$

is an arbitrary function of  $m$ .

An overhead dot denotes a differentiation with regard to  $t$  and an overhead dash a differentiation with regard to  $r$ .

In the space round this radiating charged particle, there is an expanding zone of pure radiation which itself is the seat of an electromagnetic field in addition to the Coulomb field due to the central charge.

The field equations are

$$R_{ik} - \frac{1}{2} \delta_{ik} R = -8\pi T_{ik}$$

with

$$T_{ik} = E_{ik} \quad (2)$$

where

$$4\pi E_{ik} = -F_{ik\alpha} F_{i\alpha} + \frac{1}{2} \delta_{ik} F^{\alpha\beta} F_{\alpha\beta} \quad (3)$$

$$F_{ik}^{ik} = 4\pi J^i \quad (4)$$

$$F_{[ik; j]} = 0. \quad (5)$$

The electromagnetic field round the radiating charged particle can be divided into two fields. One of them is the Coulombian field described by the non-vanishing component  $F_{14}$  of  $F_{ik}$ . The other field is due to the flowing-radiation which is described by the components  $F_{12}$ ,  $F_{24}$  of  $F_{ik}$  with the condition

$$F^{2\alpha} F_{2\alpha} = 0. \quad (6)$$

From the equations (2) to (6) for the above line-element (1) we get the values of the surviving components of  $T_{ik}$  and  $F_{ik}$  as

$$T_1^1 = \frac{e^2}{8\pi r^4} - \frac{m'}{4\pi r^2}, \quad T_2^2 = T_3^3 = -\frac{e^2}{8\pi r^4},$$

$$T_4^4 = \frac{e^2}{8\pi r^4} + \frac{m'}{4\pi r^2}, \quad \frac{\dot{m}}{m} T_1^1 = \frac{m'}{4\pi r^2} = -\frac{m}{m} T_4^4 \quad (7)$$

$$F_{14} = -\frac{(\pm e)}{r^2} \frac{\dot{m}}{m'} \left( 1 - \frac{2m}{r} + \frac{e^2}{r^2} \right)^{-1}$$

$$F_{12} = \sqrt{f(m)} \left( 1 - \frac{2m}{r} + \frac{e^2}{r^2} \right)^{-1} = -\frac{m'}{m} F_{24}.$$

The radiation density  $q$ , which is measured by an observer at rest in  $(r, \theta, \phi, t)$ , is given by

$$q = V^i V^k T_{ik} = \frac{e^2}{8\pi r^4} \quad (8)$$

with

$$V^1 = V^2 = V^3 = 0, \quad V^4 = \sqrt{g^{44}}.$$

We thus find

$$q = \frac{m'}{4\pi r^2} \quad (9)$$

As  $r$  increases the strength of both fields diminishes and at large distances from the radiating charged particle the gravitational effect of the Coulombian field vanishes first and then that due to the field of flowing radiation vanishes.

The retarded time  $u(r, t)$  is an undetermined function of  $m$ . Choosing  $u(r, t)$  as the new co-ordinate, we can put the line-element (1) into the simple form

$$ds^2 = \left( 1 - \frac{2m}{r} + \frac{e^2}{r^2} \right) du^2 + 2dudr - r^2 d\Omega^2$$

$$m = m(u), \quad e = \text{const.} \quad (10)$$

The above line-element (10) with  $e = e(u)$  has been derived by Plebanski and Stachel<sup>2</sup> from a purely geometrical consideration of the classification of  $R_{ik}$  in spherically symmetrical fields. However, it may be noted that for a

radiating Reissner-Nordström metric to satisfy Maxwell's equations  $de/du$  must vanish.

I would like to express my gratitude to Prof. P. C. Vaidya for guidance and help in this work.

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Ahmedabad-9, May 17, 1968.

1. Vaidya, P. C., *Curr. Sci.*, 1943, 12 (6), 183.
2. Plebanski and Stachel, *Einstein Tensor and Spherical Symmetry*, Undated preprint.

### A SOLUTION FOR AN ISOLATED CHARGED BODY IN ISOTROPIC CO-ORDINATES

In the course of certain investigations it was found that

$$ds^2 = - \left( 1 + \frac{L}{r} + \frac{M}{r^2} \right)^2 (dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2) + \left( 1 + \frac{M}{r^2} \right)^2 \left( 1 + \frac{L}{r} + \frac{M}{r^2} \right)^2 dt^2 \quad (1)$$

is a solution of the field equations

$$G_i^j = -8\pi E_i^j \quad (2)$$

(in the usual notations), for an isolated charged body. This can be cast into the form

$$ds^2 = - \left( 1 - \frac{2L}{r} + \frac{L^2}{r^2} + \frac{4M}{r^2} \right)^2 dr^2 - r^2 d\theta^2 - r^2 \sin^2 \theta d\phi^2 + \left( 1 - \frac{2L}{r} + \frac{L^2}{r^2} + \frac{4M}{r^2} \right) dt^2 \quad (3)$$

where we can compare it with the usual Nordström solution (Eddington, 1960)

$$ds^2 = - \left( 1 - \frac{2m}{r} + \frac{4\pi e^2}{r^2} \right)^2 dr^2 - r^2 d\theta^2 - r^2 \sin^2 \theta d\phi^2 + \left( 1 - \frac{2m}{r} + \frac{4\pi e^2}{r^2} \right) dt^2 \quad (4)$$

to get

$$L = m, \quad L^2 + 4M = 4\pi e^2 \quad (5)$$

'm' and 'e' being mass and charge of the isolated body.

It seems that the form (1) has escaped notice. For recently, Bonnor (1965) has obtained the solution

$$ds^2 = - \left( 1 + \frac{L}{r} \right)^2 (dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2) + \left( 1 + \frac{L}{r} \right)^2 dt^2 \quad (6)$$

which is a particular case of (1) when  $M=0$ . In solution (6) the constant  $L$  seems to represent both mass and charge. This undesirable feature is removed in the form (1). Further, we can write the solution (1) in the form

$$ds^2 = - \left\{ \left( 1 + \frac{m}{2r} \right)^2 + \frac{\pi e^2}{r^2} \right\}^2 (dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2) + \left\{ \frac{1}{4r^2} + \frac{\pi e^2}{r^2} \right\}^2 \left( \left( 1 + \frac{m}{2r} \right)^2 + \frac{\pi e^2}{r^2} \right) dt^2 \quad (7)$$

which reduces to Schwarzschild's exterior solution when the charge is absent, ( $e=0$ ).

If we consider an inertial test particle of proper mass  $m_p$  and relative mass  $m'$  with velocity  $V_0$  when at  $r=r_0$  in the field (1) we find that the two masses are connected (Narlikar, 1968) through the equation

$$m' = m_p \frac{A_0^2}{A^2} \frac{B^2}{B_0 (A_0^2 + B_0^4 V_0^2)^{1/2}} \quad (8)$$

where,

$$A = 1 - \frac{m}{4r^2} + \frac{\pi e^2}{r^2}, \quad A_0 = (A)_r=r_0, \\ B = \left( 1 + \frac{m}{2r} \right)^2 + \frac{\pi e^2}{r^2}, \quad B_0 = (B)_r=r_0.$$

We find that the relative mass of the particle varies along the radial direction. As the particle reaches very great distances from the source ( $1/r \rightarrow 0$ ) so that  $A \rightarrow 1$ ,  $B \rightarrow 1$ , the relative mass will be equal to a constant multiple of the proper mass.

The term  $\pi e^2/r^2$  appearing in the metric seems to be significant for the charge of an electron. We find

$$\frac{\pi e^2}{r^2} = \frac{\pi E^2 G}{c^4 r^2} = \frac{\alpha l_0^2}{2r^2} \quad (9)$$

where  $E$  is the electron charge in e.s.u.,  $G$  the gravitational constant,  $\alpha$  the fine structure constant is  $2\pi E^2/hc$ , and  $l_0$  the fundamental length associated with  $h$ , viz.,  $(hG/C^3)^{1/2}$ .

Although the metric picture of the electron is not consistent with the uncertainty principle the form (7) has an interest of its own because of the appearance of the term  $\alpha l_j^2/2r^2$ . Also, the two distinct cases  $m/2 \gtrless \sqrt{\pi e}$  deserve special attention, in relation with the singularities.

The author wishes to thank Professor V. V. Narlikar for his constant guidance in preparing this note, and the University Grants Commission for awarding a research scholarship.

Dept. of Mathematics and A. R. PRASANNA,  
Statistics, University of Poona,  
Poona-7, June 7, 1968.

1. Eddington, A. S., *The Mathematical Theory of Relativity*, 1960, p. 185.
2. Bonnor, W. B., "The equilibrium of a charged sphere," *Mon. Not. R. Astr. Soc.*, 1935, **129**, 443.
3. Narlikar, V. V., "Relative mass in general relativity," *Curr. Sci.*, 1968, **37** (10), 281

#### ESTIMATION OF LONG-WAVE RADIATION AT A TROPICAL STATION

MÜGGE AND MÖLLER (1932) were the first to suggest a graphical method to estimate the incoming long-wave radiation. A modified version incorporating practically all the principles of the above method was described by Elsasser (1940). A graphical method seems to be the best to evaluate the heat transfer in the atmosphere by the infra-red thermal radiation.

These graphical methods are capable of application upto heights of about 1 to 3 km. in the atmosphere; but at higher levels they tend to become uncertain, and at the tropopause they are quite unreliable (Goody and Robinson, 1951). The simplest possible application of the radiation charts arises in the calculation of the downcoming long-wave radiation of the atmosphere and of the effective long-wave radiation of the ground. Only a few direct comparisons of the measured and the calculated values are available. Therefore, in the present note the authors have evaluated the downcoming long-wave radiation from the atmosphere at the earth's surface at Waltair (17° 43' N., 83° 14' E.) from August, 1963 to July, 1965, with the aid of radio-sonde data for clear days, using the second revised Elsasser radiation chart (1940 and 1942). They have also measured the radiation with Beckman and Whitley Total Hemispherical Radiometer, Model H 188-1 (similar to that

of Gier and Dunkle, 1951) for the same period. The measured and estimated values show remarkable agreement as is presented in Table I.

TABLE I  
*Mean values of long-wave radiation of the  
atmosphere from Elsasser chart and radiometer*

Month	Estimated values from Elsasser diagram		Measured values from radiometer
	Langs./ 3 hr.	Langs./ hr.	Langs./ hr.
August, 1963	.. 105.35	35.12	36.40
September, 1963	.. 106.08	35.36	36.50
October, 1963	.. 102.90	34.30	34.08
November, 1963	.. 99.38	33.13	31.89
December, 1963	.. 96.58	32.19	31.78
January, 1964	.. 98.34	32.78	32.16
February, 1964	.. 99.38	33.13	32.76
March, 1964	.. 103.08	34.36	34.35
April, 1964	.. 105.26	35.09	35.22
May, 1964	.. 110.20	36.73	38.47
June, 1964	.. 109.79	36.60	37.97
July, 1964	.. 104.04	34.68	35.73
August, 1964	.. 101.84	34.61	35.86
September, 1964	.. 104.64	34.88	36.34
October, 1964	.. 103.26	34.42	34.77
November, 1964	.. 98.31	32.77	32.55
December, 1964	.. 95.87	31.96	32.48
January, 1965	.. 97.58	32.53	32.60
February, 1965	.. 98.76	32.92	32.86
March, 1965	.. 103.95	34.65	34.67
April, 1965	.. 106.14	35.38	35.46
May, 1965	.. 111.37	37.12	38.33
June, 1965	.. 110.13	36.71	37.84
July, 1965	.. 108.77	36.26	37.34

Wexler (1941) also compared measurements made in Alaska and North America under winter conditions with radiation values calculated from Elsasser's diagram and found that on the average the calculated outgoing radiation values were about 0.035 cal. cm.<sup>2</sup> min.<sup>-1</sup> higher than the observed values. This deviation, for which Wexler has no explanation must probably be ascribed to the use of the earlier edition of Elsasser radiation chart which furnishes values for downcoming radiation approximately 10% lower than the later edition of this chart. The extensive observations of Brooks (1941), Robinson (1950) and Brewer and Houghton (1956) are also important at the development of radiation charts. Robinson found that there was nearly always at Kew, available additional downward component (averaging about 3%) of long-wave radiation when observations were compared with estimates given by radiation charts. He suggested, that the most important additional radiation sources could be thin invisible

clouds, ozone and particulate matter. He also found considerable differences between these measurements and the estimates, which he attributed to the change in the emissivity of a vapour pressure layer with temperature.

It may be due to these influences, that the authors also observed slight differences in the estimated and observed values of the atmospheric long-wave radiation at Waltair. Table I shows that the differences are very small in winter months in which more clear skies prevail at Waltair. This again supports the suggestion of Robinson's observation at Kew.

Dept. of Meteorology and Y. VISWANADHAM.  
Oceanography, R. RAMANADHAM.  
Andhra University,  
Waltair, May 18, 1968.

1. Brewer, A. W. and Houghton, J. T., *Proc. Roy. Soc. London*, 1956, **236 A**, 175.
2. Brooks, F. A., *Pap. Phy. Ocean. Meteor. Mass. Inst. Tech.*, Woods Hole Ocean Inst., 1941, **8**, No. 2.
3. Elsasser, W. M., *Quart. J. Roy. Met. Soc.* (Suppl.), 1940, **66**, 41.
4. —, *Harv. Met. Stud.*, 1942, No. 6.
5. Gier, J. T. and Dunkle, R. V., *Proc. Amer. Inst. E.E.*, 1951, **70**, 339.
6. Goody, R. M. and Robinson, G. D., *Quart. J. Roy. Met. Soc.*, 1951, **77**, 151.
7. Mücke, R. and Möller, F., *Zeit. Für Geophysik*, 1932, **8**, 53.
8. Robinson, G. D., *Quart. J. Roy. Met. Soc.*, 1950, **76**, 37.
9. Viswanadham, Y., *Ph.D. Thesis*, Andhra University, S. India, 1967, p. 78.
10. Wexler, H., *Month. Weath. Rev.* (Suppl.), 1941, No. 46.

#### A NOTE ON THE COMPONENTS OF TYLOPHORA INDICA

THE leaves of *Tylophora indica* have been attracting attention, especially as a cure for asthma. In the course of the extraction of the drug for pharmacological and clinical investigations, some new observations have been made and they are reported here.

In the earlier chemical work Rathnagiriswaran and Venkatachalam<sup>1</sup> noted the presence of a compound which was considered to be a steroid. Their extraction procedure has been modified in the present study. The air-dried powdered leaves (1kg.) were exhaustively extracted at room temperature with petroleum ether (60–80°) and the extract concentrated, dried in a vacuum desiccator and chromatographed over neutral alumina (200 g.). Elution with petroleum ether gave waxy matter followed by a small amount of carotenoids.

Benzene : petroleum ether (60 : 40) eluted a compound which gave positive Liebermann-Burchard and Salkowski tests. This was purified by rechromatography over neutral alumina. It crystallised from chloroform-methanol as colourless needles (0.5 g.); m.p. 182°; elemental analysis agreed with the formula  $C_{30}H_{50}O$ ;  $[\alpha]_D^{20} +62^\circ$  ( $CHCl_3$ , 1.2%). It showed end absorption in u.v.;  $\mu_{max}^{cm^{-1}}$ , 3450 (OH) 1460 ( $CH_2$ ), 1380 ( $CH_3$ ); mass spectrum:  $M^+$  426, (M-18)<sup>+</sup> 408, base peak 218. Acetate made by (Py.  $Ac_2O$ ) method crystallised from chloroform-methanol as colourless needles, m.p. 219°; C and H values agreed with formula  $C_{32}H_{52}O_2$ ;  $[\alpha]_D^{25} +76.9$  ( $CHCl_3$ , 1.4%);  $\mu_{max}^{cm^{-1}}$ , 1760, 1250 (acetate); mass spectrum:  $M^+$  468, (M-60)<sup>+</sup> 408, base peak 218. All these data agreed with those of  $\alpha$ -amyrin and its acetate; the identity was confirmed by direct comparison.

In the subsequent alcohol (1% acetic acid) extract, besides the alkaloids<sup>2</sup> (tylophorine being the major one), flavonoids are present in small amounts. They could be extracted from the mixture by means of ether. Earlier Govindachari et al.<sup>2</sup> identified kempferol in these leaves. In our sample quercetin is also present in almost equal quantities, besides minor quantities of a third slow-moving (TLC) flavonoid, which does not agree with myricetin in its  $R_f$  or ferric chloride colour. The flavonoids are partly free and partly as glycosides.

Tylophorine is a member of the indolizidine group of alkaloids though it is of a complex structure having a major phenanthrene portion also. The indolizidine part has a tertiary nitrogen in a bridge position, just as in the case of pyrrolizidine and quinolizidine bases. The latter two are known to occur frequently as their N-oxides. In an analogous manner, it is possible for tylophorine also to be present as an N-oxide. The possible presence of this was examined in the alcohol extract of leaves as well as in the crude alkaloid fractions using colour reaction with acetic anhydride. No N-oxide was present. It was necessary therefore to make sure, if the alkaloid is capable of forming an N-oxide. Reaction with peroxybenzoic acid showed that formation of N-oxide takes place with ease, and the N-oxide has the normal properties known in other cases; however it is more easily soluble in chloroform than pyrrolizidine-N-oxides. Its preparation is given below.

Tylophorine (50 mg.) was dissolved in chloroform (5 ml.) at room temperature and a solution of peroxybenzoic acid in chloroform (0.05 M; 10 ml.) added, the mixture allowed to stay overnight and washed with aq.  $K_2CO_3$  and dried (anhydrous  $K_2CO_3$ ). After evaporation of chloroform the product was crystallised repeatedly from methanol yielding pale yellow crystals m.p. 230°. Its elemental analysis agreed with the formula  $C_{22}H_{27}O_5N$ ;  $\mu_{\text{obs}}^{25^\circ}$  915 (N = O). On heating with acetic anhydride it gave an orange-brown colour.

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University of Delhi, T. R. SESHADRI,  
Delhi-7, June 12, 1968.

1. Rathmagirisharan, A. N. and Venkatachalam, K., *Ind. J. Med. Res.*, 1934, 22, 433.
2. Govindachari, T. R., Pd. B. R. and Nagarajan, K., *J. Chem. Soc.*, 1954, p. 2802.

### MAGNETIC SUSCEPTIBILITY OF POTASSIUM BIS (TRITHIOCARBO-NATE) NICKEL (II), $K_2[Ni(CS_3)_2]$ AND ITS CONFIGURATION

POTASSIUM thiocarbonate (PTC) reagent has been widely used as precipitating and complexing agent in qualitative<sup>1</sup> and quantitative<sup>2</sup> analysis. A number of metal ions form soluble thiocarbonate complexes<sup>3</sup> with PTC. Nickel (II) yields (1:2) blood red soluble thiocarbonate complex,  $K_2[Ni(CS_3)_2]$ . The recent communication by McKeehnle and co-workers<sup>4</sup> on the geometry of bis(trithiocarbonate) nickel (II) anion, by means of a single crystal X-ray analysis on the tetraphenylarsonium salt,  $Ph_4As^+ [Ni(CS_3)_2]^{2-}$ , has prompted us to examine the magnetic behaviour of the aqueous form of the pure complex anion. Although, there are many examples of diamagnetic and paramagnetic nickel complexes in literature<sup>5</sup> no reference has been made to the magnetic behaviour of the complex,  $K_2[Ni(CS_3)_2]$ .

**Reagents.** Nickel chloride was prepared by dissolving AnalaR B. D. H. sample in redistilled water and standardised by usual method.

**Potassium thiocarbonate.** 2 M—An aqueous solution was prepared by the direct method, and after standardisation<sup>6, 10</sup> kept as a stock solution and was used after suitable dilutions.

**Potassium bis (trithiocarbonate) nickel (II)** was prepared by mixing the two solutions (equimolar) in the ratio of  $Ni^{2+} : CS_3^{2-} = 1:2$ ,

the concentration of both metal and ligand was 0.2 M.

The magnetic susceptibility of the complex was measured using the Gouy's method. The length of the Gouy tube was 16.0 cm. The tube was hung from the pan of a semimicro balance (Feinwaage HMP 53) by means of an aluminium wire so that the bottom of the tube was within the centre of the pole gap of the Leybold electromagnet (5.0 cm. pole diameter, 2.5 cm. inter pole gap). The Gouy tube was enclosed within a glass jacket, the temperature remained constant for long periods and was measured frequently.

A current of 10.0 A, reproducible within 0.1%, was used. The magnetic field was approximately 15,000 gauss and since the magnet was approaching saturation field, reproducibility was better than 0.1%; heating of the coils and core was kept to a minimum.

Aqueous nickel chloride solution was used as a calibrating liquid and its gram susceptibility has been found to be  $10^6\chi = 7.3736$  (C.G.S. units).<sup>11</sup> The gram-susceptibility of the solution was calculated from an expression used by Figgis and Lewis<sup>12</sup>:

$$10^6\chi = \frac{a + \beta F'}{\omega}$$

where  $a$  is a constant allowing for the displaced air and equal to 0.029 specimen volume,  $\beta$  is the tube-calibration constant,  $\omega$  is the weight of the specimen in grams, and  $F'$  is the force on the specimen in mg., i.e.,  $(F - \delta)$ ,  $F$  being the observed force and  $\delta$  is the loss in weight due to glass. After calculating the susceptibility of the solution, the susceptibility of the complex was derived from the following relationship based on Wiedemann's additivity law:

$$\chi_{\text{comp.}} \times W_{\text{comp.}} + \chi_{\text{sol.}} \times W_{\text{sol.}} - \chi_{\text{water}} \times W_{\text{water}}$$

where,  $\chi$  is specific gram-susceptibility and  $W$  the weight. A few representative observations are given in Table I.

TABLE I  
Results of the magnetic susceptibility measurements

No.	$t^\circ C.$	$W$ (g.)	$F'$ (mg.)	$\chi_{\text{sol.}} \cdot 10^6$	$\chi_{\text{comp.}} \cdot 10^6$
1	24.5	5.01032	-14.36	-0.8913	-8.91
2	24.5	5.01032	-14.36	-0.8913	-8.91
3	24.5	5.01032	-13.82	-0.8515	-8.50

$$\mu = 0.3219, \quad V = 4.9685 \text{ ml.}, \quad \delta = -9.94 \text{ mg.}$$

Nickel (II) being a  $d^8$ -system has 2 unpaired electrons. The value of  $\chi \cdot 10^6$  for its complex

with the thiocarbonate as ligand is found to be  $-8.91$  showing its diamagnetic character with spin-paired planar configuration involving hybridisation of the  $d_{sp^2}$  orbitals of Ni (II). However, from the order of magnitude in the value of  $\chi \cdot 10^6$  one could infer a high degree of overlap of sulphur orbitals with those of the nickel (II). From this it may be concluded that the thiocarbonate exerts a strong ligand field not allowing the  $sp^3$  hybridization, otherwise possible. This lends support to the crystallographic investigations on the tetraphenylarsonium bis (trithiocarbonate) nickel (II) anion by McKechnie *et al.*<sup>7</sup> From their X-ray study of this salt any deviation from the overall co-planarity of the six sulphur atoms with nickel(II) is traced to the tetrahedral buckling of the four co-ordinated sulphur atoms. Despite this, the occupation of  $d_{sp^2}$  orbitals is preserved by a compensation increase in the C-S-Ni angles ( $88^\circ$ ).

The authors are thankful to Prof. T. R. Seshadri for his keen interest, to Prof. R. P. Mitra for the facilities provided and to the Council of Scientific and Industrial Research, New Delhi, for the award of a fellowship to one of them (N. K. K.).

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# SPECTROPHOTOMETRIC DETERMINATION OF LEAD, COPPER AND BISMUTH IN A MIXTURE AFTER SEPARATION BY PAPER CHROMATOGRAPHY

ALTHOUGH the chloro complexes of copper, lead and bismuth strongly absorb in the ultraviolet region with characteristic absorption maxima,<sup>1</sup> direct spectrophotometric determination of these in a mixture in constant boiling hydrochloric acid is not possible due to mutual interference. In view of this difficulty, quantitative separation by paper chromatography, followed by spectrophotometric determinations is outlined in the present method. Lederer<sup>2</sup> determined the  $R_f$  values of different metal cations in alcohol : acid mixtures. Most of the solvent systems were *n*-butanol : HCl mixtures, containing hydrochloric acid of different normality varying from 1-12 N. In many of these mixtures,  $R_f$  values of lead and copper were the same and with strong hydrochloric acid those of bismuth and copper were the same. However, in a mixture of ethanol containing 10% 5N HCl, the  $R_f$  values recorded for  $Pb^{+2}$  (0.16),  $Cu^{+2}$  (0.47) and  $Bi^{+3}$  (0.94), indicate that this solvent system may be used for paper chromatographic separation of these metals applying them as their chlorides.

In the following method spectrophotometric determination of these metals after paper chromatographic separation is outlined, which shows a clean separation and good recovery of lead, copper and bismuth present in a mixture.

Whatman No. 1 chromatographic paper was cut into strips  $30 \times 2.5$  cm. Equal volumes of a mixture (containing 1,000 p.p.m. Cu and Pb and 998 p.p.m. of Bi) were then applied to two chromastrips with the help of a micro pipette at a distance of about 5-6 cm. from one end of the strip.

Paper strips were dried and then kept for an hour or two in air before subjecting to chromatographic development.

The two strips (forming a pair) were then fixed along a glass 'T' tube, keeping the spots in the two strips in parallel position. These strips were then lowered inside a cylinder of 6 cm. diameter and chromatography was performed in an ascending manner using ethanol + 10% 5N hydrochloric acid as developer. Mouth of the cylinder was closed with a rubber stopper. Development was allowed to continue for 5-6 hr. till the solvent front moved to a distance of 20-25 cm. Paper strips were

1. Johri, K. N., *Indian J. Appl. Chem.*, 1963, **26**, 114.
2. —, *Chemical Analysis without H<sub>2</sub>S (Using Potassium Trithiocarbonate)*, Asia Publishing House (Pvt.) Ltd., Bombay, 2nd Ed., 1968.
3. — and Singh, K., *Curr. Sci.*, 1965, **34**, 78.
4. — and —, *Indian J. Appl. Chem.*, 1965.
5. — and —, *Bull. Chem. Soc., Japan*, 1967, **40**, 990.
6. Bankovskis, J. and Levins, A., *Latvijas PSR, Zinatnu Akad. Vestis*, 1967, **3**, 123; *C.A.*, 1958, **52**, 5193 b.
7. James, S., McKechnie, Sandra, L. Miesel and Iain C. Paul, *Chem. Comm.*, 1967, **4**, 152.
8. Selwood, P. W., *Magnetochemistry*, Interscience Publishers, Inc., New York, 1956, pp. 199, 229.
9. Johri, K. N. and Singh, K., *Indian J. Chem.*, 1965, **3**, 158.
10. — and —, 1965, **90**, 745.
11. Nettleton, H. and Sugden, S., *Proc. Roy. Soc.*, 1939, **173 A**, 313.
12. Lewis, J. and Wilkins, R. G., *Modern Co-ordination Chemistry*, Interscience Publishers, Inc., New York, 1960, p. 412.



taken out and dried in air and one of the two strips (reference strip) was then sprayed with 0.5% oxine reagent and finally exposed to ammonia. Three distinct spots were observed in this reference strip. The lower light brown spot was due to lead, yellow spot in the middle was due to copper and the third yellow spot near the solvent front was due to bismuth (Fig. 1). These spots appeared as brown, purple and yellow respectively under ultraviolet light.

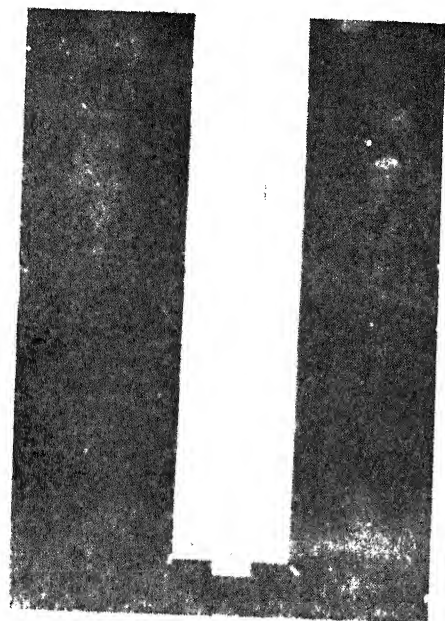


FIG. 1. Paper chromatographic separation of Pb, Cu and Bi. Lower: Pb; Middle: Cu; Upper: Bi.

Corresponding regions from the unstained paper were then cut and put inside 50 ml. conical flask. These were then eluted with 5 ml. portion of constant boiling hydrochloric acid. Extinction of these solutions were then measured. Eluate from the lower spot (lead) was measured at 270 m $\mu$  and those from the middle (Cu) and the upper spot (Bi) were measured at 275 m $\mu$  and 325 m $\mu$  respectively. Amounts of lead, copper and bismuth were calculated from their respective extinction values using their  $E_{1\%}^{1\text{cm}}$  values at these wavelengths, viz., for lead at 270 m $\mu$ : 580, copper 275 m $\mu$ : 580, Bi 325 m $\mu$ : 669. Results are shown in Table I.

The paper strips should not be kept for a long time with HCl while eluting and too much of shaking should be avoided to prevent disintegration of the paper.

TABLE I  
Determination of lead, copper and bismuth after chromatographic separation

Lead (p.p.m.)		Copper (p.p.m.)		Bismuth p.p.m.	
Found	Present	Found	Present	Found	Present
4.13	4	4	4	4	3.99
5	5	4.9	5	4.6	4.89
5.8	6	5.7	6	5.5	5.98
6.6	7	6.8	7	6.9	6.98
7.0	8	7.8	8	7.6	7.98
8.2	9	8.9	9	8.4	8.98
9.3	10	10.4	10	9.2	9.98

This method of determination is simple for once the separation is achieved, it involves only elution with constant boiling hydrochloric acid and measurement of extinctions of the eluate at the wavelength of their maximum absorption.

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1. Desesa, M. A. and Rogers, L. B., *Anal. Chim. Acta*, 1952, **6**, 534.
2. Lederer, M., *Ibid*, 1951, **5**, 185.

## THERMAL DECOMPOSITION OF FLUORIDE COMPLEXES OF THORIUM WITH HYDRAZINE AND HYDROXYLAMINE

PREPARATION of fluoride complexes of thorium with hydrazine and hydroxylamine was reported earlier.<sup>1</sup> Thermal decomposition of these complexes in vacuum yields anhydrous thorium tetrafluoride and is described in the present note.

All the chemicals used were of E. Merck quality. For the preparation of the complexes, the method adopted here were slightly different from the process reported by us earlier (*loc. cit.*). To a hot solution of thorium nitrate (70-80°C.) in presence of hydrazine or hydroxylamine, hydrochloride, 40% hydrofluoric acid was added drop wise at a slow rate, when a white crystalline precipitate of  $\text{ThF}_4 \cdot \text{N}_2\text{H}_4 \cdot \text{HF}$  or  $\text{ThF}_4 \cdot \text{NH}_2\text{OH} \cdot \text{HF}$  was readily formed and settled down. After complete precipitation, the compound was filtered, washed with absolute alcohol, dried under vacuum and analysed. Thorium was analysed as thorium dioxide, hydrazine by potassium iodate, hydroxylamine by potassium bromate<sup>2</sup> a fluoride by Badeeva's method.<sup>3</sup>

TABLE I

Compound		ThO <sub>2</sub>		Fluoride		Hydrazine		Hydroxylamine		
		Found %	Calcd. %	Found %	Calcd. %	Found %	Calcd. %	Found %	Calcd. %	
ThF <sub>4</sub> N <sub>2</sub> H <sub>4</sub> HF (I)	..	..	73.2	73.3	26.2	26.4	8.8	8.9	..	..
ThF <sub>4</sub> NH <sub>2</sub> OHHF (II)	..	..	73.1	73.1	26.0	26.3	..	..	9.0	9.2
ThF <sub>4</sub> (from I)	..	..	85.4	85.7	24.4	24.7	..	..	..	..
ThF <sub>4</sub> (from II)	..	..	85.2	85.7	24.1	24.7	..	..	..	..

The complexes were next subjected to thermal decomposition in vacuum at about 300–400°C. Both the complexes underwent rapid decomposition with elimination of various gaseous products and yielded thorium fluoride, ThF<sub>4</sub>, in the anhydrous state. Analytical data are given in Table I above.

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1. Sahoo, B. and Patnaik, D., *Curr. Sci.*, 1961, **30**, 293.
2. Vogel, A. I. A., *Text Book of Quantitative Inorganic Analysis*, 3rd Edition, 1962, **540**, 380, 391.
3. Badeeva, I. I. and Shevakii, C. N. G., *State University Saratov, Zavodskaya Lab.*, 1955, **21**, 787.

### CHLOROBENZENESULPHONYL ESTERS OF 8-QUINOLINOLS AND PHENOLS

ESTERS of 5-chloro-, 5, 7-dichloro- and 5, 7-dibromo-8-hydroxyquinoline have been reported<sup>1,2</sup> to possess enhanced bactericidal and fungicidal properties in comparison with the corresponding 8-hydroxyquinolines. Carbonates,<sup>1,3</sup> nicotines,<sup>2</sup> benzoates<sup>1,5</sup> and acetates<sup>6</sup> of 8-hydroxyquinolines have been prepared and claimed to possess interesting antibacterial and antifungal properties.

In connection with our work on sulphonamides and benzothiadiazines<sup>7,8</sup> we had occasion to synthesize 2, 6-dichloro-, 2, 4, 6-trichloro-, 3, 5-dichloro- and 2, 6-dichloro-4-sulphamylbenzenesulphonyl chloride. These sulphonyl chlorides have been reacted with 8-hydroxyquinoline, 5-chloro-, 5, 7-dichloro- and 5, 7-dibromo-8-hydroxyquinoline to obtain the corresponding sulphonates (Table I). 2, 6-Dichloro-4-sulphamylbenzene-sulphonyl chloride has also been reacted with phenol, o-cresol, p-cresol, 2-naphthol and p-acetylaminophenol to

obtain the corresponding esters (Table I). The reactions were carried out in acetone or aqueous acetone in presence of potassium carbonate or alkali.

A few typical experiments are described in Table I.

8-(3', 5' - Dichlorobenzenesulphonyloxy) - 5 - chloroquinoline.—To a stirred and refluxing suspension of 5-chloro-8-hydroxyquinoline (3.6 g.) and potassium carbonate (1.4 g.) in acetone (60 ml.) was added dropwise a solution of 3, 5-dichlorobenzenesulphonylchloride (4.9 g.) in acetone (20 ml.). The reaction mixture was stirred and refluxed for one hour. Acetone was distilled off; the residue was treated with cold dilute hydrochloric acid to obtain the crude title product (5.2 g.). It was crystallised from benzenehexane; m.p. 113–14°. Found: N, 3.74; Calc. for C<sub>15</sub>H<sub>8</sub>Cl<sub>3</sub>NO<sub>3</sub>S: N, 3.61%.

8-(2', 6' - Dichlorobenzenesulphonyloxy) - 5, 7 - dichloroquinoline.—To a stirred suspension of 5, 7-dichloro-8-hydroxyquinoline (1.1 g.) and 2, 6-dichlorobenzenesulphonyl chloride (1.2 g.) in acetone (20 ml.) at room temperature was added dropwise a solution of sodium hydroxide (1.5 g.; 4 ml.). The reaction mixture was stirred for 10 minutes and poured into ice (100 g.) and hydrochloric acid (2 ml.) to obtain the crude title product (1.4 g.). It was crystallised from acetone-alcohol; m.p. 141–43°. Found: N, 3.44; Calc. for C<sub>15</sub>H<sub>7</sub>Cl<sub>4</sub>NO<sub>3</sub>S: N, 3.31%.

2 - (2', 6' - Dichloro - 4' - sulphamylbenzenesulphonyloxy) - naphthalene.—To a stirred solution of 2-naphthol (1.4 g.) in aqueous acetone (30 ml.; 5 ml.) containing sodium hydroxide (1.5 g.) was added at room temperature 2, 6-dichloro - 4 - sulphamylbenzenesulphonylchloride (3.2 g.). The reaction solution was warmed to 50°, cooled and acidified with dilute hydrochloric acid to obtain the crude title product (4.1 g.). It was crystallised from acetone-alcohol; m.p. 193–94°. Found: N, 3.40; Calc. for C<sub>16</sub>H<sub>11</sub>Cl<sub>2</sub>NO<sub>5</sub>S<sub>2</sub>: N, 3.50%.

TABLE I

No.	Name	m.p. °C.	Nitrogen %	
			Found	Calc.
1	8-(2', 6'-Dichlorobenzene-sulphonyloxy)-quinoline	145-46	4.06	3.96
2	8-(2', 6'-Dichloro-4-sulphamylbenzenesulphonyloxy)-quinoline	191-92 (d)	6.26	6.47
3	8-(2', 4', 6'-Trichlorobenzene-sulphonyloxy) quinoline	166-67	3.80	3.61
4	8-(3', 5'-Dichlorobenzene-sulphonyloxy)-quinoline	119-21	4.04	3.96
5	8-(2', 6'-Dichlorobenzene-sulphonyloxy)-5-chloroquinoline	162-63	3.35	3.61
6	8-(2', 6'-Dichloro-4-sulphamylbenzenesulphonyloxy)-5-chloroquinoline	193-95	5.81	5.99
7	8-(2', 4', 6'-Trichlorobenzene-sulphonyloxy)-5-chloroquinoline	158-59	3.29	3.31
8	8-(3', 5'-Dichlorobenzene-sulphonyloxy)-5-chloroquinoline	113-14	3.74	3.61
9	8-(2', 6'-Dichlorobenzene-sulphonyloxy)-5, 7-dichloroquinoline	141-43	3.44	3.31
10	8-(2', 6'-Dichloro-4-sulphamylbenzenesulphonyloxy)-5, 7-dichloroquinoline	164-66	5.35	5.58
11	8-(2', 4', 6'-Trichlorobenzene-sulphonyloxy)-5, 7-dichloroquinoline	150-52	3.28	3.06
12	8-(3', 5'-Dichlorobenzene-sulphonyloxy)-5, 7-dichloroquinoline	164-66	3.12	3.31
13	8-(2', 6'-Dichlorobenzene-sulphonyloxy)-5, 7-dibromoquinoline	155-56	2.98	2.74
14	8-(2', 6'-Dichloro-4-sulphamylbenzenesulphonyloxy)-5, 7-dibromoquinoline	181-82	5.00	4.75
15	8-(2', 4', 6'-Trichlorobenzene-sulphonyloxy)-5, 7-dibromoquinoline	168-69	2.72	2.56
16	8-(3', 5'-Dichlorobenzene-sulphonyloxy)-5, 7-dibromoquinoline	128-30	3.16	2.74
17	2-(2', 6'-Dichloro-4-sulphamylbenzenesulphonyloxy)-naphthalene	193-94	3.40	3.50
18	4-(2', 6'-Dichloro-4-sulphamylbenzenesulphonyloxy)-acetaldehyde	172-74	6.17	6.38
19	2-(2', 6'-Dichloro-4-sulphamylbenzenesulphonyloxy)-toluene	162-64	3.61	3.54
20	4-(2', 6'-Dichloro-4-sulphamylbenzenesulphonyloxy)-toluene	173-74	3.51	3.54
21	2, 6-Dichloro-4-sulphamylbenzenesulphonyloxybenzene	160-61	3.49	3.67

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#### GALLIUM CONTENT IN BAUXITE ORES OF MARIYANSHOLA, PALNI HILLS, KODAIKANAL TALUK

PRESENCE of gallium in bauxite ores has been reported in literature. The present note reports the results of preliminary estimation of gallium content in the bauxite ore of the Palni Hills, Kodaikanal. A Number of pits have been dug in five different hills by the State Geological Department for assessing the quality of the ore. Random samples from different pits on these hills were taken for purpose of determining the gallium content. Gallium was determined by the Rhodamine-B Method. The samples are in two forms: (i) The chunks which are solid rocks or lumps taken at various depths and (ii) the fines, the material collected after sieving through approx. 50 mesh. The chunks are rich in alumina,

1. Battelle Institute, *Ger. Pat.*, 1,193,945; *Chem. Abstr.*, 1960, **63**, 8327<sup>b</sup>.
2. Fiedler, H. and Kallen, U., *Pharmazie*, 1966, **21**, 239; *Chem. Abstr.*, 1966, **65**, 1891<sup>c</sup>.
3. Riedel de Haen, A. G., *Ger. Pat.*, 1,199,774; *Chem. Abstr.*, 1965, **63**, 18,052<sup>c</sup>.
4. Griot, R., Renz, J., Bouquin, J. P. and Schenker, E., (to Sandoz Ltd.), *U.S. Pat.*, 3,136,768; *Chem. Abstr.*, 1964, **61**, 6997<sup>b</sup>.
5. Chugai Pharmaceutical Co., *Jap. Pat.*, 22,742; *Chem. Abstr.*, 1966, **64**, 8156<sup>b</sup>.
6. Sandoz Ltd., *Brit. Pat.*, 977,334; *Chem. Abstr.*, 1965, **62**, 7736<sup>b</sup>.
7. Somasekhara, S., Dighe, V. S., Suthar, G. K., Dighe, N. K. and Mukherjee, S. L., *Ind. J. Chem.*, 1968, **6**, 19.
8. —, — and Mukherjee, S. L., *Curr. Sci.*, (In press).

ranging from 48-58%, and low in silica and iron oxide content. The fines are silicious and ferruginous in nature and low in  $Al_2O_3$  content, 35-45% only.

X-ray and diffraction analyses of some samples have revealed that the silica is present as free quartz and also in the combined state as kaolinite and halloysite. The average gallium content in samples from pits on Hill No. 1 ranges from 35 to 40 ppm, (i.e.), about 1 to  $1\frac{1}{2}$  oz. of the metal can be recovered from a ton of raw material. In Hill No. 2 the average gallium content falls between 20 to 30 ppm, while in Hill III and Hill V it is estimated at 45 to 50 ppm.

My grateful thanks are due to the Department of Industries and Commerce, Government of Madras, for offering facilities to conduct this work.

Office of the

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1. *Colorimetric Metal Analysis by Sandell*, Third Edition, p. 473.

### A NOTE ON THE ORIGIN OF WALTAIR HIGHLANDS

THE Waltair Highlands form the most conspicuous feature over an area of 4 square miles in the vicinity of Visakhapatnam (Long.  $83^\circ 12' - 83^\circ 21'$ ; Lat.  $17^\circ 39' - 17^\circ 46'$ ) attaining locally a height of about 100 feet above mean sea-level. W. King (1886) attributed these badlands to represent the denudational remnants of a great sand bank of the post-Pliocene times or isolated banks formed around the then sunken hills. Mahadevan and Sathapathi (1949) concluded that these highlands might have been formed by the cumulative work of wind and running water. During a recent survey made by the authors, two types of deposits have been recognised, namely, (1) the red loamy deposit with ferruginous clay as matrix, and (2) the red concretionary material with calcium carbonate as matrix. The occurrence of the latter type of material, however, has been constantly missing in the literature in spite of its peculiar occurrence and its close relation with the red loamy deposits. The object of the present note is to account for the origin of bad lands based on different size parameters and their scatter plots.

As many as 30 samples have been collected both vertically and laterally, and the grain size parameter are calculated (Folk and Ward, 1957). All the samples are positively skewed and mesokurtic. A comparative list of values such as, mean size, standard deviation, kurtosis, and kurtosis of both badlands and Mustang Island (C. C. Mason and Folk, 1958) are presented in Table I.

TABLE I

Description	Values	(Mz) Mean	(σ) Standard deviation	(SK) Skewness	
Waltair-Highlands	Maximum	1.93	.538	0.2226	1.005
	Minimum	1.71	.428	0.0484	0.800
Mustang Island	Average	1.85	.489	0.1140	0.965
	Average	2.86	.273	0.1390	1.070

The scatter plots such as mean size vs. standard deviation and kurtosis vs. skewness are shown in Fig. 1 and Fig. 2 respectively.

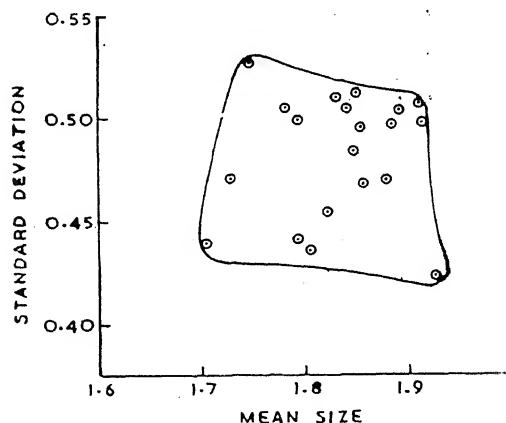


FIG. 1. Scatter plot of mean size versus standard deviation.

The authors arrive at the following conclusions from the field observations and laboratory data:

(1) The absence of lamination, current bedding, size gradation and shelly material indicate that the deposit is mainly a wind-borne one.

(2) The red loam appearance is a result of the cumulative processes of decomposition of feldspars and oxidation of ferruginous minerals.

(3) The remarkable uniformity of grain size and well-sorted nature might be due to the prevalence of high winds with uniform energy conditions during post-Pliocene times.

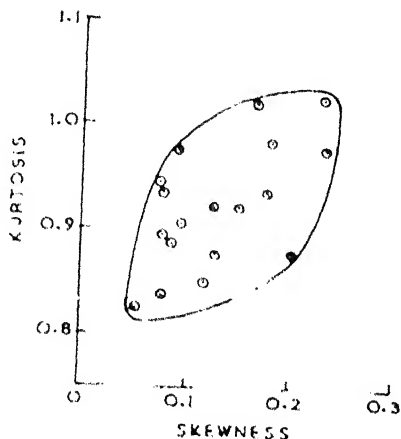


FIG. 2. Scatter plot of skewness versus kurtosis.

(4) The scatter plots, such as mean size vs. standard deviations, and kurtosis vs. skewness, obtained which are considered to be very sensitive for the differentiation of environments, are very much similar to the plots obtained for the dunes of Mustang Islands, and thus confirm a typical dune environment for Waltair Highlands.

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1. King, W., *The Geological Sketch of Tringapattinam District Record*, G.S.I., 1886, 19, 143.
2. Mahadevan, C., and Sathapathi, N., "The origin of the Waltair Highlands," *The Indian Geographical Journal*, 1919, 24.
3. Meeson, C. C., and Folk, R. L., "Differentiation of Beach Dune and Aeolian Flat Environments by size analysis," Mustang Island, Texas, *Journal of Sedimentary Petrology*, 1958, 28.
4. Folk, R. L. and Ward, W. C., "Brazos River Bar: A study in the significance of Grain Size Parameters," *Ibid.*, 1957, 27.

# OCCURRENCE OF A TRYPANORHYNCHAN LARVA IN AMPHIOXUS (*BRANCHIOSTOMA LANCEOLATUM*)

The life-cycle of any marine trypanorhynchid is incompletely known. However, records of their occurrence in various invertebrates and vertebrates have been mentioned by several authors.<sup>1-3</sup>

In a routine examination of *Branchiostoma lanceolatum* dredged from the inshore waters of Madras coast three specimens were found to be infected. Figure 1 shows, in a sagittal section of amphioxus, a larva (T) in the

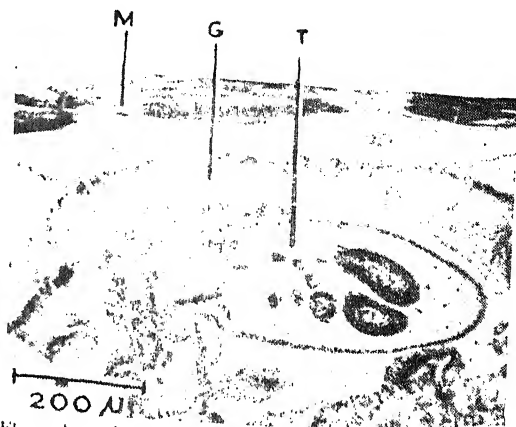


FIG. 1. Trypanorhynchid larva in the midgut of amphioxus. M, myotome. Rest of the letterings are referred in the text.

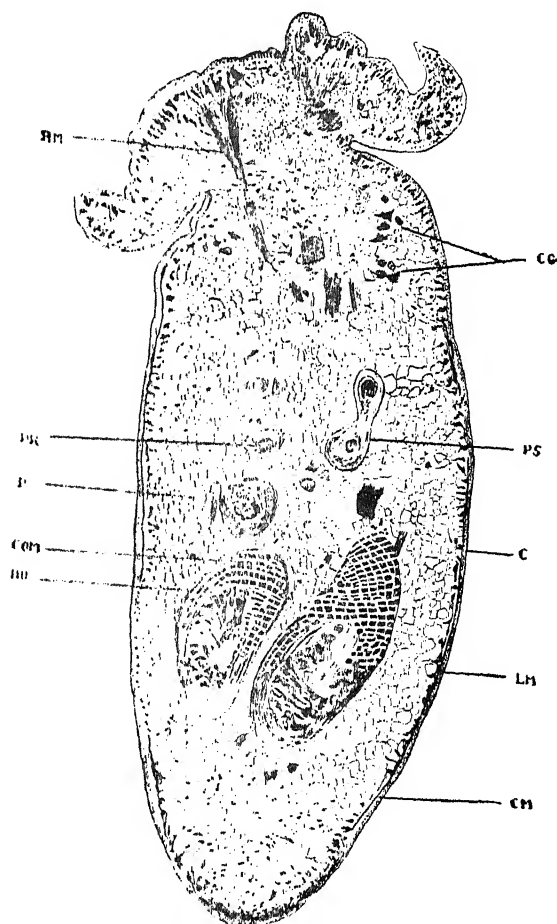


FIG. 2. Camera lucida drawing of trypanorhynchid larva. midgut region (G). As a result of a critical examination of the

sections, a reconstruction of the entire structure of the larva was possible. It was found to recall the morphology of a Trypanorhynchian larva, differently called plerocercoid or plerocercus.

The larva (Fig. 2) is solid with an external conspicuous cuticle (C) underlying which are the circular (CM) and longitudinal muscles (LM). The substance of the larva, the parenchymal tissue (P) appears as a spongy matrix containing a good amount of calcareous granules (CG). At the anterior end are four bothria each having a typical sucker-like appearance. The body showed four pear-shaped bulbs (BU) at the posterior end, each clothed with a set of strong concentrically laid out muscle (COM) bands and leading to a convoluted proboscis sheath (PS). The proboscides (PR) were all kept in a retracted state inside the sheath by the retractile muscle (RM) and they did not show any armature. They reach the anterior end in the apical area encircled by the bothria.

The identification of the larva is hardly possible, but it could be expected without doubt to reach the adult stage in some other marine animal probably a selachian, which should inject the amphioxus along with various other marine organisms.

I am thankful to Prof. G. Krishnan, for his interest in the work and to Prof. M. Anantharaman, Madras Veterinary College, for identifying the larva and for helpful suggestions.

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Madras-5, May 1, 1968.

1. Hyman, L. H., *The Invertebrates*, Vol. II, *Platyhelminthes and Rhynchocata*, McGraw-Hill, New York, 1951.
2. Southwell, T., *Cestoda*, Fauna of British India, London, 1930.
3. Subhapradha, C. K., "Helminth parasites of the economic fishes of the Madras coast," *M.Sc. Thesis*, Madras University, 1948.

#### TISSUE ASCORBIC ACID CONTENTS IN THE SCORBUTIC BULBUL (*PYCNONOTUS CAFER*)

ROY AND GUHA<sup>1</sup> have reported that the red-vented bulbuls (*Pycnonotus cafer*, family: Pycnonotidae, order: Passeriformes) is the only bird amongst non-mammalian species, which cannot synthesize vitamin C like man, monkey, guinea-pig and Indian fruit bat

because of the lack of an enzyme, L-gulonoxidase (Chatterjee *et al.*<sup>2</sup>). These authors have shown that neither the liver nor the kidney (sites of synthesis in vertebrates) of bulbuls could normally synthesize vitamin C. Roy and Guha<sup>3</sup> have further shown that the bulbuls can be made scorbutic experimentally when they develop certain patho-morphological changes like general debility, drooping of head, sloughing of feathers, loss of body-weight, internal hemorrhage, etc. Although these symptoms are somewhat typical for scurvy, a study on the concentration of the ascorbic acid in tissues would finally confirm the scorbutic condition of the animal. As *Pycnonotus* is the only avian species developing scurvy symptoms, it seems desirable to quantitate the vitamin C concentration of various tissues belonging to the scorbutic bulbul.

Twenty-four red-vented bulbuls were used in the present investigation. The scorbutogenic diet (*vide* Roy and Guha<sup>3</sup>) was given to both the control and the treated birds *ad libitum* for twenty-one days. The control birds' diet was supplemented with vitamin C (3 mg. each daily) during the course of the experiment. Different tissues (*vide* Table I) were quickly

TABLE I  
Tissue ascorbic acid contents of scorbutic bulbul

(mg./100 gm. fresh wet tissue)

Tissue	Control (12)*	Scorbutic (12)	Per cent. depletion	p. value
Adrenal	248.78 ± 20.07†	46.28 ± 8.95	81.72	< .001
Spleen	98.28 ± 9.01	23.73 ± 5.16	75.85	< .001
Pancreas	89.05 ± 10.22	20.79 ± 4.26	76.65	< .001
Kidney	77.95 ± 10.77	40.96 ± 7.97	47.45	< .025
Liver	71.95 ± 9.31	33.62 ± 6.80	53.27	< .005
Uropygial gland	138.97 ± 12.15	32.21 ± 6.11	76.82	< .001

\* Number of animals shown in parenthesis.

† Standard error of the mean.

dissected out, cleaned and weighed on a torsion balance. Ascorbic acid concentration of these tissues were estimated following the method of Roe and Kuether.<sup>4</sup>

A perusal of Table I reveals a significant depletion of tissue ascorbic acid following scurvy. The depletory pattern of this species in the bulbul appears to be almost similar to that of the guinea-pigs (Banerjee<sup>5</sup>). A close inspection of Table I further reveals that the kidney and the liver of scorbutic bulbuls retain a large amount of the vitamin. It may not be

out of place to mention that similar findings have also been recorded in the liver of the scorbutic guinea-pigs.<sup>1</sup> Since these organs are the original sites for synthesis of ascorbic acid in both the animals,<sup>2</sup> one is apt to surmise that kidney and liver in bulbuls and liver in guinea-pigs might be able to synthesize vitamin C under abnormal physiological state possibly to replenish the loss of the vitamin. It is interesting to note that other tissues of bulbuls also retained some amount of the vitamin following scurvy. The cause for this retention of vitamin C in these animal species remains unexplained. Our present findings biochemically confirm the earlier patho-morphological changes of bulbuls in scurvy.

The author wishes to thank Sri. G. K. Chakrabarty for providing laboratory facility. This work has been supported by a scholarship from the University of Calcutta. The author is grateful to Dr. Asok Ghosh for guidance.

Histophysiology Laboratory, B. MATHI,  
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Calcutta-19, May 4, 1968.

1. Roy, R. N. and Guha, B. C., *Nature*, 1958, **182**, 319.
2. Chatterjee, I. B., Kar, N. C., Ghosh, N. C., and Guha, B. C., *Ann. N. Y. Acad. Sci.*, 1961, **92**, 36.
3. Roy, R. N. and Guha, B. C., *Nature*, 1958, **182**, 1689.
4. Roe, J. H. and Kueher, C. A., *J. Biol. Chem.*, 1943, **147**, 399.
5. Banerjee, S., *Bull. Nat. Ind. Sci. India*, 1960, **17**, 79.

# OCURRENCE IN NATURE OF COLLATERAL HOSTS (*CYPERUS* *ROTUNDUS* AND *C. DEFFORMIS*) OF *XANTHOMONAS ORYZAE*. INCITANT OF BACTERIAL BLIGHT OF RICE

In India bacterial blight of rice incited by *Xanthomonas oryzae* (Uyeda and Ishiyama). Dowson, of late, has appeared in a very serious form often threatening to assume epidemic proportion. The incitant has not yet been found to attack any other graminaceous or other host plants in nature. During the course of field observations in search of any collateral hosts, two species of *Cyperus*, namely, *Cyperus rotundus* L. and *Cyperus defformis* L. were observed to show symptoms similar to those exhibited on rice leaves due to attack of *X. oryzae*.

The leaves of *Cyperus rotundus* and *C. defformis* showed water-soaked necrotic spots followed by tip-blight, leaf-drying and ulti-

mately death of the whole plant. The dried leaf tip and the green healthy portion of the leaf-base were sharply demarcated by distinct line of separation.

The pathogen was isolated from the infected leaves of *Cyperus* spp. and their morphological and biochemical properties were studied. Isolates were compared with those isolated from rice. The bacterium as studied was gram negative, rod with single polar flagellum, producing circular, smooth, glistening, wax-yellow colonies on nutrient agar. It did not liquefy gelatin and hydrolyse starch. It produced  $H_2S$  and acidified milk slightly. It could produce acid but no gas from glucose, lactose and sucrose with a long incubation. These characters were found to tally with those specified in *Bergey's Manual of Determinative Bacteriology* (7th Edition)<sup>2</sup> for *Xanthomonas oryzae* (Uyeda and Ishiyama) Dowson.

Pathogenicity tests were carried out on both the species of *Cyperus* and paddy (variety Dular) with the isolates from grasses as well as with isolate from infected leaves of Dular variety. In all the cases the isolates readily produced infection three days after spraying. Within 7 days the typical drying of leaves from tips reached a stage of severe damage to the plant, the whole plant becoming blighted and dried. Re-isolation from all the cases of cross inoculations gave the isolates having same morphological and biochemical characters.

The leaf blight of these weeds was severe in heavy monsoon as in the case with the rice-leaf blight. Earlier the role of seeds in carrying over of the pathogen from one rice crop to the next, has been established in this laboratory. The occurrence in nature of two common perennial weeds as collateral hosts might be a great contributory factor for the perpetuation and spread of the disease. So far the studies made for host range of *X. oryzae* have not included any member of the family Cyperaceae.<sup>1</sup>

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West Bengal, January 30, 1968.

1. Anonymous, ICAR, *Final Report of the Scheme for Investigation into Bacterial Blight of Paddy in Maharashtra State*, Dept. of Agriculture, Maharashtra State, 1964.
2. Breed, R. S., Murray, E. G. and Smith, N. R. (Eds.), *Bergey's Manual of Determinative Bacteriology*, (7th Edn.). The William and Wilkin Co, Baltimore, 1957.

**PSILOSPORA GEN. NOV., A NEW  
FOSSIL POLLEN GENUS FROM  
THE MESOZOIC ROCKS OF KUTCH,  
W. INDIA**

THE present paper describes *Psilospora* gen. nov., a new pollen genus recovered from the Katrol (Upper Jurassic) and the Bhuj (Lower Cretaceous) sediments of Kutch. The material consisted of buff to grey-coloured shales which were macerated following the method described by us in an earlier paper.<sup>1</sup>

**GENUS *Psilospora* GEN. NOV.**

Type Species—*Psilospora lata* Sp. Nov.

**Generic Diagnosis.**—Pollen oval-elliptical in shape. Exine thick, laevigate, furrows present along longer axis.

**Description.**—Mostly oval in shape with broad lateral ends, elliptical forms are also encountered in studied material. Size range  $65-150 \times 40-80 \mu$ . Exine  $2-6 \mu$ , laevigate, sometimes weakly infrastructured. Furrows variable, in some specimens only one distinct furrow is present while in others upto 4 have been observed. Among over hundred specimens studied none shows splitting along equatorial axis.

**Comparison.**—*Schizosporis* Cookson & Dettmann (1959)<sup>2</sup> is mostly circular-subcircular in shape, splits into two halves along the equator and is ornamented. Among the four species included under this genus by Cookson and Dettmann,<sup>2</sup> *S. reticulatus* and *S. rugulatus* show distinct exocxinal ornamentation while two species, i.e., *S. spriggi* and *S. parvus* do not show any exocxinal ornamentation; hence it is here proposed to restrict *Schizosporis* to ornamented forms. *S. spriggi* as compared to the specimens recovered from Indian sediments is distinctly circular with a furrow or an aperture running along the equator (cf. *Zonaperturate*) splitting the pollen into two almost equal halves. *S. parvus* is ovoid and is thus comparable to the Indian fossils but shows a distinct equatorial furrow. The specimens described here as *Psilospora lata* are larger in size with a thick exine showing one or more furrows running along the longitudinal axis of the pollen, no split forms have been encountered. *Ovoidites* Potonié (1951)<sup>3</sup> resembles the present genus in shape but is distinguished by its rugose-reticulate ornamentation.<sup>4,5</sup>

***Psilospora lata* Sp. Nov.**

**Holotype**—Fig. 1, Figs. 1-5



FIGS. 1-5. *Psilospora lata* Gen. et sp. nov. Fig. 1. Holotype, ca,  $\times 500$ .

**Type Locality.**—Trambau, near Bhuj, Bhuj Series (Lower Cretaceous), Kutch, India.

**Specific Diagnosis.**—Pollen oval,  $100-140 \times 58-80 \mu$ . Exine  $3-6 \mu$  thick, laevigate. Furrows present extending along longer axis.

**Description.**—Pollen mostly oval with equally broad lateral ends. Exine in most specimens



navigate, sometimes weakly intrapunctate. Furrows well developed, parallel to each other, extending from one end to the other.

**Distribution.** Katrol (Upper Jurassic) and Bhuj (Lower Cretaceous) sediments of Kutch.

The type slides are preserved in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

Birbal Sahni Inst. of Palaeobotany, Lucknow, April 5, 1968.  
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1. Venkatachala, B. S. and Kar, R. K. *Curr. Sci.*, 1967, 36 (22), 613.
2. Jackson, L. C. and Dettmann, M. *Mycol. Science*, 1959, 5 (2), 213.
3. Potonie, R. *Protoplasma*, 1951, 6, 272.
4. J. de Venter, A., *Ann. Bot. Soc. Bot. Soc. Bot.*, 1934, 5, 1.
5. Krutzsch, W. *Protoplasma*, 1959, 105 B, 125.

### OCCURRENCE OF *MOUGEOTIA ELEGANTULA* WITTRÖCK FROM GWALIOR, MADHYA PRADESH

The present communication is a report on the occurrence of *Mougeotia elegantula* Wittröck, described for the first time from India, as far as known to the author.

Filaments 3-5.6-0.5 broad; cells 46-0.115-0.9 long; single chloroplast with 4-8 pyrenoides in a row. Conjugation scalariform, conjugating cells geminate; zygospores quadrate, 18-5.24-2.2  $\mu$  broad with rounded corners, blackish; spore wall smooth and hyaline. Aplanospores could not be observed (Figs. 1-3).



FIGS. 1-3. *Mougeotia elegantula*, Wittröck. Fig. 1. Vegetative filament. Fig. 2-3. Filaments with zygospores.

The material was collected from a Tank (Gwalior fort) mixed with *Spirogyra* and *Zygnema* sp., on 11th March 1966.

Material and slides have been deposited with Botany Department, Government Science College, Gwalior.

I acknowledge my sincere thanks to Principal Dr. Raviprakash and Prof. T. N. Raghwar, for encouragement and facilities.

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Gwalior (M.P.), March 1, 1968.

1. Kaulhawa, M. S., *Zygnemacra*, I.C.A.R., New Delhi, 1959.

### TWO NEW RECORDS OF *PESTALOTIA* FROM BANGALORE

In the course of investigations on soil mycoflora of Bangalore, two species of *Pestalotia* (*sensu*) Guba<sup>1</sup> were isolated, one from termites hill soil and the other from the rhizosphere of *Pisum sativum* L. The species were isolated by the Warecup's<sup>2</sup> soil plate method. Recently, Rao<sup>3</sup> has reported an unidentified species of *Pestalotia* from soils at Tirupati.

1. *Pestalotia heterocornis* Guba in *Monocharia and Pestalotia*, 1961, pp. 125-26.

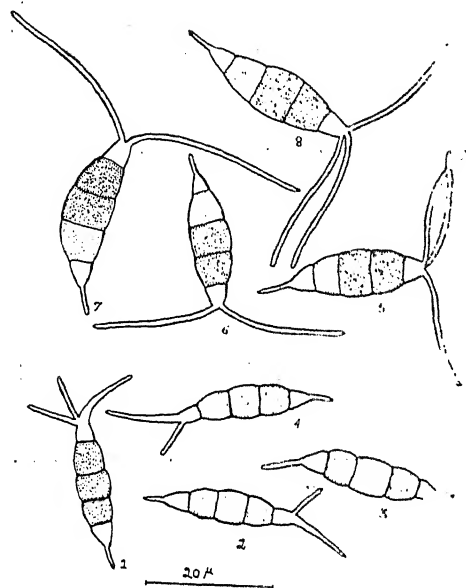
Conidia 5-celled, fusiform, tapering towards the extremities, straight, slightly constricted at the septa, 18-26  $\times$  4.5-8  $\mu$ ; intermediate cells pale brown, somewhat olivaceous, concolorous 12-15  $\mu$ , apical cell hyaline conic or slightly cylindrical bearing two to three, rarely one or four widely divergent setulae, mostly unequal in length, 4-13  $\mu$ , pedicel upto 8  $\mu$  long (Figs. 1-4).

*Pestalotia heterocornis* was originally described on leaves of *Anacardium occidentale* L. The isolate under report, obtained from the termite hill soil, differs from the type in having slightly shorter setulae.

2. *Pestalotia ardisiae* P. Henn. *Hedwigia*, 1902, 41, 116; Guba, E. F., in *Monocharia and Pestalotia*, 1961, pp. 202.

Conidia 5-celled, fusiform, straight, rarely bent, tapering towards the extremities, 24-33  $\times$  7-9  $\mu$ , hardly constricted at the septa, basal cell fairly long, acute, upper two cells umber-coloured, the lower olivaceous 13-18  $\mu$ ; setulae 2-3, mostly three, rarely four, diverging at right angles to the conidia 15-33  $\mu$  long and pedicel 4-8  $\mu$  long (Figs. 5-8).

*Pestalotia ardisiae* was originally described on leaves of *Ardisia grandis* Seem from Botanic Gardens, São Paulo, Brazil. The local isolate from the rhizosphere soil of *Pisum sativum* L., agrees closely with the above species but differs in having slightly longer and narrower conidia.



FIGS. 1-8. Figs. 1-4. *Pistatitia heterornis* (for explanation refer text). Figs. 5-8. *Pistatitia ardesiæ* (for explanation refer text).

Our sincere thanks are due to Dr. M. Nagaraj for providing facilities and to Dr. V. Agnihothrudu, Technical Advisor, Rallis, India, for confirming the species.

Department of Botany, PADMABAI LUKE.  
Central College, S. SUDARSHANA DEVI.  
Bangalore, May 17, 1968.

1. Guba, E. F., *Monozetia and Pestotia*, Harvard University Press, 1961, p. 342.
2. Rao, A. S. *Curr. Sci.*, 1965, **34**, 489.
3. Warcup, J. H. *Nature*, London, 1950, p. 117.

#### KARYOTYPE AND CYTOLOGY OF *SPINIFEX LITTOREUS* MERR.

*Spinifex littoreus* Merr. (*S. squarrosus* Linn.), a member of the tribe Paniceæ, is a wild dioecious grass growing on the seashore sands. Except for the report of the chromosome number of  $n=9^1$  and  $2n=18^2$  little is known about the cytology of this genus. A study of karyotype and meiosis of this species was undertaken to detect, if any, chromosomal heteromorphism that might be associated with the dioecious condition.

Material was obtained from the natural populations growing in the Waltair beach (India). Root tips were collected from the same clones (one male and one female) throughout the study. Root tips, half inch

long, were pretreated in 0.002% 8-hydroxy-quinoline for four hours at 16–18° C. and squash preparations were made in aceto-orcein.<sup>3</sup> For meiosis flower-buds were fixed in 1 : 3 acetic-alcohol and stained in aceto-carmin.

The somatic complements in the root tips showed 18-chromosomes in both male and female plants (Figs. 1, 2). The 18-chromo-

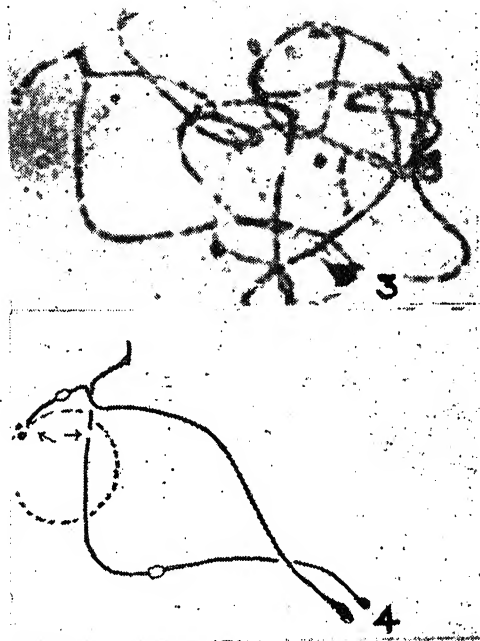


FIGS. 1-2. Fig. 1. Metaphase pole view in male plant,  $\times 1000$ . Fig. 2. Metaphase pole view in female plant,  $\times 1000$ .

somes could be identified as 9 pairs. Measurements of the individual chromosomes were made from 12 cells each of the male and female plants. All the chromosomes had submedian centromeres. There was a gradual decrease in length from the longest to the shortest chromosome in the complement. In both male and female plants chromosome 2 was identified as the nucleolus organiser chromosome, with the nucleolus organiser situated in the long arm sub-terminally. This chromosome measured  $4.5\mu$  and  $5.0\mu$  in male and female plants respectively. All the chromosomes except chromosomes 6 and 7 could be identified on the basis of total length and arm-ratio. Chromosomes 1, 2 and 9 are the easiest to identify in the complement. The karyotypes of the male and female plants agree very well and the results indicate the absence of a heteromorphic pair in either sex.

Meiosis in pollen mother cells showed 9 bivalents at diakinesis and metaphase-I. Analysis of 60 nuclei at diakinesis and 36 at

metaphase-I showed no evidence of a heteromorphic pair. At pachytene the bivalents were well spread and stained. Conspicuous knobs, comparable to those on maize chromosomes, were discernible which were mostly terminal. Though only one pair of chromosomes was observed at karyotype to have nucleolus organiser, at pachytene two bivalents were observed with attachment to nucleolus (Figs. 3, 4). One of the bivalents compares



FIGS. 3-4. Pachytene showing the nucleolus organiser bivalents.

with chromosome 2 of karyotype in having the nucleolus organiser constriction near the end of the long arm. The second bivalent attached to the nucleolus had the nucleolar constriction near the centromere. However, this could not be identified in the somatic karyotype. At anaphase-I there was regular disjunction followed by equal distribution of chromosomes. Subsequent stages of meiosis were found to be normal. Meiotic irregularities were, however, observed in the material collected in bulk from a large number of plants. The irregularities observed were occurrence of 2 to 4 univalents at diakinesis and metaphase-I; 8 : 10 distribution, delayed disjunction, disjunction bridges and bridge

and fragment at anaphase-I. During pollen mitosis the expected 9-chromosomes were observed; in a few grains, however, the diploid number of chromosomes were observed.

My thanks are due to Prof. J. Venkateswarlu under whose guidance this work was carried out.

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1. Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, George Allen & Unwin Co., Ltd., London, 1956.
2. Tateoka, T., *Curr. Sci.*, 1959, 28, 78.
3. Tjio, J. H. and Levan, A., *An. Est. Aula Dei.*, 1950, 2, 21.

#### BEAKED PALEA, A CHEMICALLY INDUCED MUTANT CHARACTER IN RICE

THIS note records the isolation of a new mutant character, *beaked palea*, in the  $M_3$  generation of annual wild rice (*O. rufipogon* Griffith, which is closely related to cultivated rice) following seed treatment with two chemicals diethyl sulphate (DES) and maleic hydrazide (MH). The distinctive features of the mutant are in spikelets, which are reduced in size and in which palea is markedly longer than lemma and beaked in shape, and lemma itself is curved backwards at the apiculus end (Fig. 1).



FIG. 1. Spikelets of normal *O. rufipogon* (left) and mutant plant (right). Palea are shown by arrows.

Dormant seeds of a culture of *O. rufipogon* collected from Adarthal, Madhya Pradesh, India, were soaked in water for 48 hr. and treated successively with dES 1.5 ml.-%/90 min. in phosphate buffer (7.0 pH) and MH 2.24-%/90 min. at 25° C. with periodic stirring. The seeds were rinsed in water and planted in flat pans. Out of 25 seeds, 23 seeds germinated and 11 seedlings grew to maturity. These were harvested singly and  $M_2$  populations grown with 30 plants/progeny. The mutant character arose in the  $M_3$  generation in four plants (out of 38 plants) in the progeny of an  $M_2$  plant (No. 602-1312-1) that was selected originally for its short stature, semisterility and high tiller number. Seeds from these plants were collected and  $M_4$  progenies grown and they bred true showing complete penetrance and expressivity of the mutant character.

This character has not been reported before.<sup>1,3</sup> However, this mutation involves modification to the fertile glumes of the spikelet and other types of modifications to lemma and palea have been recorded such as *open hull*, *claw-shaped hull*, *triangular hull*, *beaked lemma*, *long palea*, *depressed palea* and *underdeveloped palea*.<sup>1,3</sup> In the present case, reduction in lemma length (8.0-6.0 mm.) was more than that of palea (<8.0-7.0 mm.) but the beaked appearance of palea was the most prominent and characteristic modification. Further, the plants possessing this modification are also characterised by a more compact habit, shorter stature (two-thirds of normal which is 90-125 cm. depending on season and fertility), higher tiller number (about one-fifth more) dark green leaves and, reduction in panicle length (19-14 cm.), spikelet number/panicle (85-64 nos.), spikelet fertility (60-48%) and 1,000-grain weight (25.5-21.0 g.) as compared to the original plant. This may be an instance of pleiotropic effect.

This character, *beaked palea*, is assumed to be inherited by two recessive duplicate genes for the following reasons. (i) It first appeared in the  $M_3$  generation with the family segregating 34 normal : 4 *beaked palea* (P for 15 : 1 ratio is 0.20-0.50, for 3 : 1 is <0.05). (ii) It did not appear in the  $M_2$  generation though the  $M_2$  families consisted of 30 plants each, which is large enough for a recessive monogenic character to show up. (iii) When  $M_4$

families of six morphologically normal  $M_2$  plants were grown (20 plant family), four bred true for normal appearance, one segregated 19 normal to one *beaked palea* (P for 15 : 1 ratio is 0.80-0.95, for 3 : 1 ratio is <0.05) and the sixth family segregated 18 normal to two *beaked palea* (P for 15 : 1 ratio is 0.20-0.50, for 3 : 1 ratio is 0.05-0.20). (iv) With a 15 : 1 segregation, 1/16  $F_3$  families (here,  $M_4$  families) should breed true for recessive character, 4/16 each should segregate in 3 : 1 and 15 : 1 ratios and the remaining, that is, 7/16 families, should breed true for dominant character. With a 3 : 1 segregation, 1/4 families each should breed true for dominant and recessive characters and the remaining families should segregate in 3 : 1 ratio. In the present case, the recessive plants bred true in  $M_4$  generation, and, of the  $M_4$  families of six morphologically normal  $M_2$  plants grown, four families bred true and two segregated as detailed above. Assuming a 15 : 1 segregation, the P value is 0.20-0.50 if it is taken that both families segregated in the ratio 15 : 1 and P value is 0.50-0.80 if it is taken that one family each segregated in 15 : 1 and 3 : 1 ratio, both alternatives being probable as given in (iii) above. Since one of the  $M_4$  families segregated only in a 15 : 1 ratio (as indicated by chi-square tests), a monohybrid segregation cannot be assumed in the present case. The character *beaked palea* is, therefore taken to be controlled by two recessive loci and these are designated  $bp_1$  and  $bp_2$ .

The authors are thankful to Dr. S. Y. Padmanabhan, Director, for giving facilities and encouragement and to Mr. S. Sampath, Cytogeneticist and Dr. B. Misra, Geneticist, for discussions. This research has been financed in part by a grant under PL 480.

Central Rice Res. Institute, N. M. NAYAR,  
Cuttack-6, Orissa (India), P. J. JACHUCK,  
March 30, 1968.

1. Anonymous, *Rice Gene Symbolization and Linkage Groups*, ARS 34-28, Agricultural Research Service, United States Department of Agriculture, 1963.
2. Chang, T. T. and Jodan, N. E., *Intern Rice Commission Newsletter*, 1963, 12 (4), 18.
3. Misra, B., Richharia, R. H. and Thakur, R., *Oryza*, 1966, 3 (1), 96.

### HIGH YIELDING POTENTIAL IN INDICA RICES

High yield in rice has been associated with certain type of plant architecture, viz., short height and non-lobing character, with stiff erect leaves which do not shade one another. Such plants give linear response to nitrogen levels of 100 or 150 kg./ha; also they give a return of 30-40 kg. of grain per kg. of nitrogen added, especially at the lower levels. With the discovery of such types amongst the indica rices in Taiwan, a break-through in rice crop yield has become possible in South-East Asian countries where hitherto tall indica types were generally grown. Yields upto 6-10 tons of grain per hectare have been obtained in this new type of high yielding varieties.

The yield potential of a variety under a given set of field conditions is a function of the number and weight of panicles per unit area; the weight of each panicle being determined by the number of grains borne in the panicle and their average weight. An analysis of the high yielding varieties with respect to the characters mentioned above is given in Table I.

TABLE I  
Panicle characters of high yielding varieties  
(under 100 kg./ha)

Name of varieties	No. of days to head	No. of ears bearing tillers	No. of grains per ear	1000 grain weight in grams	Rice quality
Tachung Native-1	82	15.0	87	24.0	Medium
IR.8	94	12.2	131	29.0	"

The high yielding attained by T.N.1, is primarily due to its high tillering, whereas both in number of grain per panicle and their average weight, IR.8 is superior to T.N.1. As agronomic practices like spacing and fertilizer application can compensate few tillering ability, IR.8 has higher yield potential than T.N.1.

Yield can, therefore, be pushed up if types could be isolated with high spikelet number with high average weight of grains. With this objective in view the genetic stocks of rice at the Central Rice Research Institute were screened and it was found that there were

at least six types which had 300 grains per panicle with an average weight of 30 gm. per thousand grains. The data on tillering capacity, number of grains per panicle, grain weight, etc., of these varieties are presented in Table II. The varieties were grown only under 60 kg./ha in the studies.

TABLE II  
Panicle characters of new Sources of germ-plasm (under 60 kg./ha)

Name of varieties	No. of days to head	No. of ears bearing tillers	No. of grains	1000 grains weight in grams	Rice quality
Ac. 2794	130	5.3	406	30.0	Medium
Ac. 2624	130	7.1	340	30.0	"
Ac. 3358	122	4.3	301	31.7	Coarse
Ac. 844	135	7.4	410	30.5	"
Ac. 2178	135	6.3	291	34.5	"
MNP.36	135	5.0	340	38.0	"

It may be seen that the total number of grain per plant (panicle number  $\times$  No. of grains) is somewhat more (above 2000) in the varieties presented in Table II as against 1300-1600 of T.N.1 and IR.8. Therefore, the chief characteristics of the varieties in Table II, which is to be transferred through hybridization to a high yielding background represented by the varieties in Table I, is the spikelet number per panicle. As far as the grain weight is concerned, though it is true that the varieties in Table II have a greater weight, especially MNP 36, coarseness of grain which is associated with greater weight might meet considerable consumers' resistance. Very coarse grained types might have a limited use only for conversion into breakfast food. Of the 6 varieties listed in Table II, therefore, Ac. 2794 and Ac. 2624 may prove better parents than others. The reaction of these varieties to principal diseases and pests have also been taken up for study, so that simultaneously they could be improved in this direction also, if found necessary.

Alternatively, it is also considered that induction of mutations through physical and chemical mutagens might be another line of approach to bring down the height and duration of the varieties in Table II.

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## REVIEWS AND NOTICES OF BOOKS

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Sets, Functions, and Probability. By John B. Johnston, G. Baley Price and Fred S. Van Vleck. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1968. Pp. viii + 376. Price 89 sh.

This book serves to provide a foundation in sets, functions, and probability. Illustrations, applications, and exercises are chosen largely from the fields of business and management science, the biological sciences, and the social sciences. Matrix multiplication is occasionally employed in certain applications; it is not treated in this book, but can be found in the authors' *Linear Equations and Matrices*. The treatment of probability theory is abstract in the sense that the proofs of the fundamental properties of a probability space are valid without change in case the sample space is not finite.

The contents of this book are: 1. Elementary Set Theory; 2. Relations and Functions; 3. Difference Equations and Growth Functions; 4. Counting Methods; 5. Probability Spaces; 6. Some Elementary Applications; 7. Conditional Probabilities and Independence; and 8. Random Variables. C. V. R.

Calculus of One Variable. By Joseph W. Kitchen, Jr. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1), 1968. Pp. xiii + 785. Price 78 sh.

The author's objective is to provide a richly textured, flexible text with a variety of options in addition to a solid core of standard material. The book's starting point is the characterization of the real numbers as a complete ordered field; the development of calculus which then follows is quite rigorous. The basic topics of limits and inequalities also receive a thorough treatment. Illustrative examples and figures abound, and problems of many types are provided.

The contents of this book are: 1. Preliminaries; 2. Analytic Geometry of Straight Lines and Circles; 3. Limits; 4. Techniques of Differentiation; 5. Completeness of the Real Numbers; 6. Mean-Value Theorems and Their Applications; 7. Antidifferentiation and its

Applications; 8. The Riemann Integral; 9. Transcendental Functions; 10. Techniques of Integration; 11. Higher-Order Mean-Value Theorems; 12. Plane Curves; and 13. Infinite Series. C. V. R.

Advanced Quantum Mechanics. By Sakurai. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London), 1968. Pp. xii + 336. Price 140 sh.

The book covers the usual fundamental topics, in addition to a number of diverse topics designed to address a wide community of physicists. These topics, emphasizing physical understanding rather than problem-solving, include radiation damping, dispersion relations, the Lamb shift, the field-theoretic formulation of the Pauli exclusion principle, conservation of parity, and a simple illustration of the Feynman rules from the theoretic point of view.

This book will be found useful as a primary text in advanced quantum mechanics or as a supplement in courses in quantum mechanics and introductory field theory. C. V. R.

Modern Elementary Differential Equations. By Bellman. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1968. Pp. xii + 196. Price 59 sh.

The book is intended to provide students, as well as practising engineers and scientists, with an understanding of the basic methods used to obtain numerical solution of differential equations using both desk and digital computers. Prior or concurrent study of the rudiments of FORTRAN programming is required for an understanding of the chapter discussing these methods. The balance of the book, however, assumes only an elementary course in calculus, containing the rudiments of the theory of power series.

The subject-matter in this volume is dealt with in six chapters, viz., The Origins of Differential Equations, Second-Order Linear Differential Equations with Constant Coefficients. Power-Series Solutions, The Numerical Solution of Differential Equations, Linear Systems and Nth-Order Differential Equations and Existence and Uniqueness Theorems. C. V. R.

Lange's Handbook of Chemistry (Revised 10th Edition.) Compiled and Edited by Norbert Adolph Lange. (McGraw-Hill Book Company, International Division, 330 West 42nd Street, New York, New York 10036). 1967. Pp. xiv + 2001. Price \$12.00.

This book is the result of many years' experience in the compiling and editing of data useful to chemists. In it an effort has been made to select material to meet the needs of chemists who cannot command the unlimited time available to the research specialist, or who lack the facilities of a large technical library.

The subject-matter has been dealt with under four headings, viz. Life and Fire Hazard; Chemical and Physical Properties of Classified Substances; Elements, Minerals Inorganic Compounds; Organic Compounds; Industrial Materials and Chemical Analysis; Miscellaneous Tables of Specific Properties; and Conversion Factors and Numerical Tables.

The book will also serve as a reference volume for all requiring ready access to chemical and physical data used in laboratory work and manufacturing.

C. V. R.

A Petrography of Australian Metamorphic Rocks. By Germaine A. Joplin. (Published by Angus and Robertson Ltd., 221, George Street, Sydney). Pp. 262. Price \$8.00.

This book is a companion volume to the author's work on Igneous Rocks, and like it, is illustrated only with Australian material. The book is in four parts. The first part gives a brief account of nomenclature, classification and structure of metamorphic rocks. Local metamorphism is discussed in Part II, and deals with contact metamorphism, contact metamorphism, pyrometamorphism and dislocations. Palaeozoic regional metamorphism is discussed in Part III, while Precambrian metamorphism is dealt with in Part IV. The treatment is systematic and although repetition could be noticed they provide continuity of presentation making the book an easy aid to students.

There are 71 figures, nearly each one a triplet, giving microdrawings of about 200 Australian metamorphic rocks. Chemical analyses of most rock-types are also listed.

The book is an addition to the literature on Australian geology and will be of particular interest to student geologists.

A. S. G.

The Indian Ephemeris and Nautical Almanac, 1969. (Published by the Manager of Publications, Civil Lines, Delhi-6). Pp. xxii + 464. Price: Inland Rs. 14-00; Foreign 32 sh. 8d. or \$5.04.

The present publication which is the twelfth in the series of the Annual Indian Ephemeris is for the year 1969. It closely follows the pattern of the previous volumes, but it is to be noted that in this volume the revised value of the flattening of the earth ( $1/298.25$ ) has been fully incorporated in the relevant tables. The elements of eclipses have also been corrected, and the revision of the horizontal parallax of the Moon has been indicated as a footnote on the concerned pages, while those of the planets have been fully revised.

The publication makes available to the *Panchang* makers in the country the necessary astronomical data in a separate section, namely, Part V—Indian Calendar, pages 388–437. The calculations are given in Indian Standard Time, and the calendar is extended up to March 22, 1970 to cover the end of the Saka year 1891 of the National Calendar.

A. S. G.

RIC Reviews. (Published by the Royal Institute of Chemistry, 30 Russell Square, London, WC1.)

*RIC Reviews* is a new review journal published by the Royal Institute of Chemistry. Appearing twice a year at an annual subscription of £2 p.a. (£1 to RIC members), it aims to interest all chemists who want to keep abreast of developments in chemistry outside their particular sphere of activity and who find articles in the other review journals often too specialised.

The first issue under review contains the following articles: Chemistry and the Consumer by Eirlys Roberts; Role of Transition Metal Ions in Biological Processes by R. J. P. Williams; Infra-Red and Raman Spectra of Inorganic Compounds by H. E. Hallam; Structure and Properties of Water by D. J. G. Ives and T. H. Lemon.

It is an indispensable journal to all libraries, students and teachers of chemistry and physics.

A. S. G.

Electromagnetic Depth Soundings. By L. L. Vanyan. (Translated from Russian, Consultants Bureau, New York). Pp. 312.

Electromagnetic methods have been used in geophysical explorations for quite some time.

Until recently the principal application has been in mining geophysics, in the search for conductive ore bodies. Only within the past decade has the theory been advanced to the point where interpretations of layered earth structures, such as are of interest in petroleum exploration and engineering geology, can be made.

This collection of Russian translation which provides a unified approach to the subject contains the following five articles by L. L. Vanyan and co-workers: Electrical Prospecting with the Transient Magnetic Field Method; Fundamentals of Electromagnetic Sounding; Concerning Some Causes for the Distortion of Transient Sounding Curves; Concerning the Factors Distorting Frequency Sounding Curves; and Four-Layer Master Curves for Frequency Electromagnetic Sounding.

George V. Keller, the translator, has provided an Introductory chapter to the volume.

A. S. G.

**Chemical Principles in Practice.** Edited by Jerry A. Bell. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W. 1., England), 1967. Pp. 275. Price 27 sh.

This laboratory manual includes 33 experiments designed to serve high-level introductory chemistry courses in university classes. It can be used as a supplement to the regular college chemistry text-books, by instructors and students to devise and plan their practical courses in chemistry.

A. S. G.

**Experimental Measurements: Precision, Error and Truth.** By N. C. Barford. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London, W. 1), 1968. Pp. 143. Price 18 sh.

This book provides a good introduction for beginning students to understand and get interested in the calculation of errors, and the theory of errors. The publishers may think of bringing out a less expensive edition to make it within reach of all over-seas sixth-form and university entrance students.

A. S. G.

## ANNOUNCEMENTS

### Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Chemistry to the following: Sri. T. S. R. Prasada Rao, Sri. U. Murali Krishna, and Sri. V. Kameswara Rao.

Utkal University has awarded the Ph.D. degree in Chemistry to Shri Phanindra Bhushan Das.

Sri Venkateswara University has awarded the Ph.D. degree in Zoology to Sri. S. Govindappa.

### Exhibition of Research Instruments

An Exhibition of Instruments manufactured in the GDR will be held for the first time in India at the GDR Exhibition Centre, Mistry Bhavan, Dinshaw Vachha Road, Bombay-1, from 4th November to 16th November 1968.

This Exhibition is arranged by the Deutsche Export-und Importgesellschaft FEINMECHANIK-OPTIK mbH, Berlin, in co-operation with the Trade Representation of the GDR in India, Bombay, and will cover a wide range of:

Instruments for Control and Regulating purpose.

Material Testing Machines of all kinds for Laboratories and Workshops.

Precision Measuring Instruments like Precision Indicating Micrometers, Laboratory Instruments.

Electro-medical and X-Ray Equipment and Various other Medical Instruments.

### Books Received

*The Institute of Physics and the Physical Society—Reports on Progress in Physics* (Vol. XXX), Part II (1967). (The Institute of Physics and the Physical Society, London, S.W. 1), 1968. Pp. 375-831. Price £2 2 sh.

*Progress in Mathematics* (Vol. 2) *Mathematical Analysis*. Edited by R. V. Gamkrelidze. (Plenum Publishing Corp., New York 10011), 1968. Pp. viii + 161. Price \$15.00.

*Electromagnetic Depth Soundings*. By L. L. Vanyan. (Plenum Publishing Corp., New York 10011), 1967. Pp. vii + 312. Price not given.



# MUTATIONAL ANALYSIS OF PLOIDY LEVEL IN *ORYZA SATIVA*

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SINCE the determination of chromosome number in *Oryza sativa* by Kuwada<sup>7</sup> divergent views as to whether it is a diploid or a secondary auto- or allopolyploid, have been expressed by various workers. Based on the occurrence of secondary association Lawrence<sup>8</sup> considered rice as a secondary polyploid derived from an ancestor having seven pairs of chromosomes. Sakai,<sup>12</sup> Nandi<sup>10</sup> and Okuno,<sup>11</sup> on the other hand, favoured five as the basic number. Yamaura<sup>15</sup> visualized rice as an allopolyploid derived from forms having five and seven pairs of chromosomes. From the results obtained with haploid rice, Hu<sup>4,5</sup> argued in favour of *O. sativa* being a secondary polyploid. The results of Morinaga and Fukushima,<sup>9</sup> Hirayoshi,<sup>3</sup> Shastri *et al.*,<sup>14</sup> Bouharmont,<sup>1</sup> Sen<sup>13</sup> and Katayama<sup>6</sup> however do not support this hypothesis.

In the present study, an attempt was made to understand the ploidy level in rice based on its radiobiological response.

Two subspecies of *O. sativa*, namely *indica* and *japonica* represented respectively by the varieties Taichung Native-1 and Taichung 65 were treated with several doses of gamma-rays and Ethylmethane sulfonate (EMS). The chlorophyll mutation frequency was estimated as percentage of plant and spike progenies segregating in the  $M_2$ . In  $M_3$  two types of populations were grown. First, the progenies of normal-looking plants occurring in the  $M_2$  families containing mutations were grown in separate family rows. Secondly, the progenies of  $M_2$  families in which no phenotypically detectable mutation occurred were grown in separate family rows.

Estimation of mutation frequency as measured by the percentage of families segregating for chlorophyll mutations in these two types of populations showed that the  $M_3$  families derived from families segregating for mutations in the  $M_2$  had more mutations than those derived from families which did not contain mutations in the  $M_2$ . However, on the whole, the mutation frequency in  $M_3$  was lower than in  $M_2$  (Figs. 1, 2, 3, 4). Thus, several of the phenotypically normal plants in segregating  $M_2$  lines must have been heterozygous for recessive mutations. An extremely low frequency of mutations realised in  $M_3$  in non-

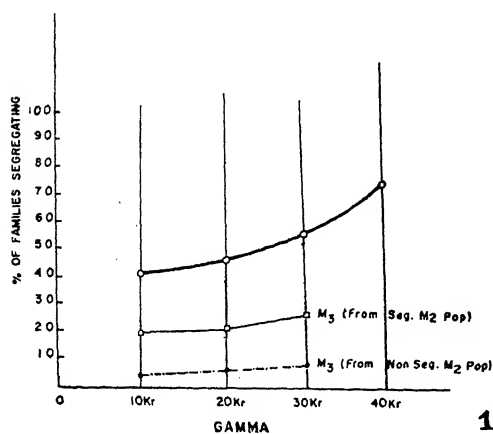
segregating lines suggests that rice behaves more like a diploid in this respect, since in polyploids, mutations find phenotypic expression more readily in later generations.<sup>15</sup>

A further approach to the study of the ploidy level was made through recurrent treatments with mutagens. Pooled seed samples of those plants which were normal-looking in the  $M_1$  were subjected to two different doses of gamma radiation. The frequency of chlorophyll mutation as measured by the percentage of mutants in the total population was compared in the recurrently irradiated and the regular  $M_2$  populations. The data indicated that the mutation frequency was either unrelated or even reduced in recurrently irradiated material (Table I). Gaul<sup>2</sup> found that recurrent radiation treatments increase the frequency of mutation in polyploids and that the

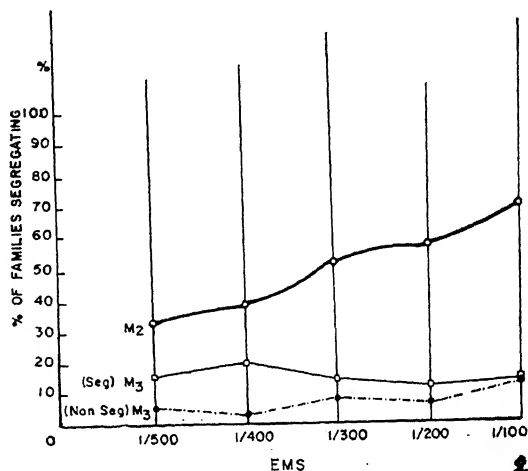
TABLE I  
Frequency of chlorophyll mutations in recurrently irradiated Taichung Native-1 and Taichung-65

Variety	$M_1$ dose	Recurrent dose	Total number of seedlings	Number of chlorophyll mutants	% of chlorophyll mutants
Taichung Native-1 ( $M_1$ seeds)	15KR	..	2280	25	1.066
	15KR	15KR	1918	19	0.990
	30KR	..	1729	18	1.041
	30KR	30KR	1554	13	0.836
Taichung-65 ( $M_1$ seeds)	10KR	..	2071	21	1.014
	10KR	10KR	1345	17	1.263
	20KR	..	1367	18	1.316
	20KR	20KR	1163	15	1.289

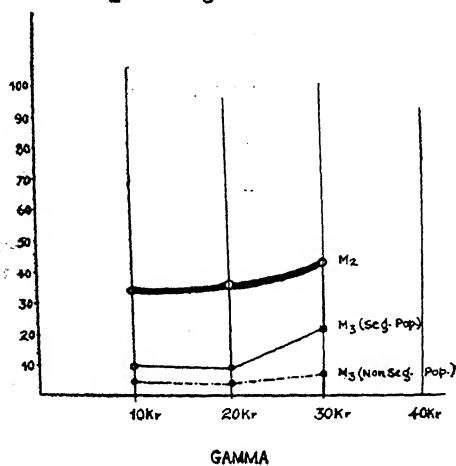
mutation frequency increases with an increase in the number of radiation cycles. Swaminathan<sup>16,17</sup> working with *Gossypium* and *Triticum* demonstrated that different types of polyploids respond differently to recurrent irradiation. Had rice been a polyploid with homologous relationships among the constituent genomes, the chlorophyll mutation frequency following recurrent irradiation could have been expected to show a rise. The data on the other hand showed a reduction in the mutation frequency in the recurrently irradiated population. Thus, in its mutational-response pattern, *O. sativa* behaves like barley

FREQUENCY OF CHLOROPHYLL MUTANTS IN  
M<sub>2</sub> AND M<sub>3</sub> TAICHUNG NATIVE-I

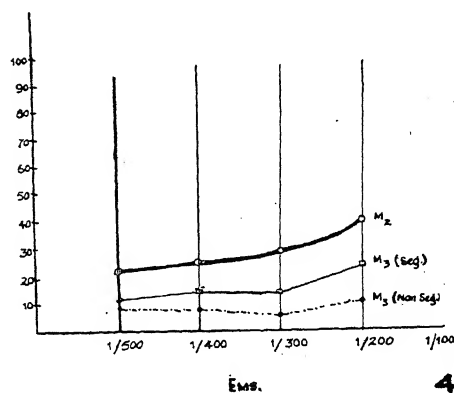
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FREQUENCY OF CHLOROPHYLL MUTANTS IN  
M<sub>2</sub> AND M<sub>3</sub> TAICHUNG NATIVE-I

2

FREQUENCY OF CHLOROPHYLL MUTANTS IN  
M<sub>2</sub> AND M<sub>3</sub> (TAICHUNG-65)

3

FREQUENCY OF CHLOROPHYLL MUTANTS IN  
M<sub>2</sub> AND M<sub>3</sub> (TAICHUNG-65)

4

FIGS. 1-4

or other diploids. If polyploidy had been involved in its phylogenetic history, either the parents must have had distinctly divergent genomes or else, a considerable degree of genetic diploidization must have occurred subsequent to its origin.

1. Bouharmont, J., *Cytologia*, 1962, **27**, 258.
2. Gaul, H., *Radiation Botany*, 1964, **4**, 155.
3. Hirayoshi, I., *Cytologia Suppl. Proc. Int. Genet. Symp.*, 1957, p. 293.
4. Hu, C. H., *Jap. J. Genet.*, 1958, **33**, 296.
5. —, *Cytologia*, 1960, **25**, 437.
6. Katayama, T., *Jap. J. Genet.*, 1965, **40** (1), 25.
7. Kuwada, Y., *Bot. Mag.*, 1910, **24**, 267.

8. Lawrence, W. J. C., *Cytologia*, 1931, **2**, 352.
9. Morinaga, T. and Fukushima, E., *Jap. J. Bot.*, 1934, **7**, 73.
10. Nandi, H. K., *J. Genet.*, 1936, **33**, 315.
11. Okuno, J., *Fac. Sci. Hokkaido Imp. Univ. Series*, **V**, 1944, **5**, 215.
12. Sakai, K., *Jap. J. Genet.*, 1935, **11**, 145.
13. Sen, S. K., *Nucleus*, 1963, **6**, 107.
14. Shastry, S. V. S., Ranga Rao, D. R. and Misra, R. N., *Ind. J. Genet. & Pl. Breed.*, 1960, **20**, 15.
15. Swaminathan, M. S., *Ind. J. Genet.*, 1967, **17**, 102.
16. —, *Proc. Symp. Effects Ioniz. Rad-Seeds* (Vienna), 1961, p. 279.
17. —, *Symp. Use of Induced Mutations in Plants Breeding* (FAO/IAEA-Rome), 1964, p. 619.
18. Yamaura, A., *Bot. Mag. Tokyo*, 1933, **47**, 551.

# NORMAL VIBRATIONS OF N, N-DIMETHYLPROPIONAMIDE

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**E**XTENSIVE work has been done in regard to the spectroscopic studies and normal co-ordinate treatment of primary and secondary amides and their deuterated analogues.<sup>1-4</sup> Recently the authors<sup>5</sup> have recorded the Raman and infrared spectra of some tertiary amides and have carried out their normal co-ordinate treatment in order to assign the vibrational frequencies and investigated the mixing up of skeletal frequencies. The Raman and infrared spectra of N,N-dimethylpropionamide were recorded by the authors<sup>6</sup> and the assignments were reported.

The authors report in this paper the normal co-ordinate treatment of N,N-dimethylpropionamide treating it as a six-body problem and using general quadratic force field.

TABLE II  
Force constants of N,N-dimethylpropionamide

$f_d = f_c = 5.3$	$f_{ad} = f_{ae} = 1.2$
$f_c = 3.8$	$f_{ca} = 1.2$
$f_b = 9.0$	$f_{ba}^d = 0.1$
$f_a = 6.8$	$f_{aa}^b = 0.8$
$f_{ab} = 1.2$	$f_{ba}^b = 1.2$
$f_{bc} = 0.9$	$f_{ca}^a = 1.2$
$f_{ca} = 0.8$	$f_{ca}^{ea} = 0.4$
	$f_{ca}^{bc} = 0.9$

TABLE I  
Symmetry co-ordinates for the in-plane vibrations of N,N-dimethylpropionamide

Symmetry co-ordinates	Vibrational mode
$R_1 = 1/\sqrt{2} (\Delta d - \Delta e)$	N-CH <sub>3</sub> asymmetric stretching
$R_2 = 1/\sqrt{2} (\Delta d + \Delta e)$	N-CH <sub>3</sub> symmetric stretching
$R_3 = \Delta c$	C-C <sub>2</sub> H <sub>5</sub> stretching
$R_4 = \Delta b$	C=O stretching
$R_5 = \Delta a$	C-N stretching
$R_6 = 1/\sqrt{6} (2\Delta de - \Delta ad - \Delta ae)$	CH <sub>3</sub> -N-CH <sub>3</sub> bending
$R_7 = 1/\sqrt{2} (\Delta ac - \Delta bc)$	C-H deformation
$R_8 = 1/\sqrt{2} (\Delta ad - \Delta ae)$	CH <sub>3</sub> -N-CH <sub>3</sub> rocking
$R_9 = 1/\sqrt{6} (2\Delta ab - \Delta ac - \Delta bc)$	O=C-N bending

This molecule belongs to the point group C<sub>s</sub> and therefore the twelve fundamental frequencies are classified into 9 in-plane (A') and 3 out-of-plane (A'') vibrations. The orthonormalised set of symmetry co-ordinates for the in-plane vibrations are given in Table I.

The structure parameters used in these calculations are:  $r(C=O) = 1.23 \text{ \AA}$ ,  $r(C-N) = 1.29 \text{ \AA}$ ,  $r(C-C) = 1.55 \text{ \AA}$ ,  $r(N-C) = 1.47 \text{ \AA}$ ,  $\angle O=C-N = 123^\circ$ ,  $\angle N-C-C_2H_5 = 117^\circ$ ,  $\angle C_2H_5-C=O = 120^\circ$ ,  $\angle C-N-CH_3 = 120$  and  $\angle CH_3-N-CH_3 = 120^\circ$ .

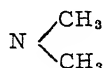
The method of obtaining F-, G- and L-matrices and calculating the frequencies and potential energy distribution are same as reported earlier.<sup>5</sup> At the first instance the force constants of N,N-dimethylacetamide<sup>5</sup> were transferred and the values of a few constants were to be adjusted to obtain a close fit between the observed and calculated frequencies. They are given in Table II.

The observed and calculated frequencies, the potential energy distribution of each normal mode among the various symmetry co-ordinates are given in Table III.

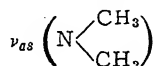
TABLE III  
Potential energy distribution of different modes of vibrations

Frequencies in cm. <sup>-1</sup>		Symmetry co-ordinates									
Observed	Calculated	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	R <sub>4</sub>	R <sub>5</sub>	R <sub>6</sub>	R <sub>7</sub>	R <sub>8</sub>	R <sub>9</sub>	
1280	1298	38	13	2	31	12	6	0	2	0	
760	734	3	45	13	7	10	2	3	3	3	
1014	1008	20	24	30	0	4	6	4	0	30	
1668	1683	6	1	3	58	17	1	6	9	8	
1495	1524	21	7	5	0	42	4	0	9	23	
480	501	10	1	34	7	9	26	6	13	7	
395	386	3	0	6	1	12	24	18	30	12	
243	240	1	0	0	1	0	0	34	49	16	
575	580	0	8	24	0	2	29	13	1	10	

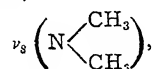
The bands at  $1280\text{ cm}^{-1}$  and  $760\text{ cm}^{-1}$  are due to the asymmetric and symmetric stretching vibrations of



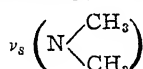
group. It can be seen from Table III that to the



mode of vibration,



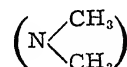
$\nu(\text{C}=\text{O})$  and  $\nu(\text{C}-\text{N})$  modes of vibrations contribute considerably. But for



only  $\nu(\text{C}-\text{C}_2\text{H}_5)$  makes substantial contribution. The band at  $1014\text{ cm}^{-1}$  is assigned to the  $\nu(\text{C}-\text{C}_2\text{H}_5)$  and the potential energy distribution shows that the contribution from  $(\text{N}-\text{CH}_3)$  stretching and  $\delta(\text{O}=\text{C}-\text{N})$  bending vibrations to this mode are considerable. The bands at  $1668\text{ cm}^{-1}$  and  $1495\text{ cm}^{-1}$  are assigned to  $\nu(\text{C}=\text{O})$  and  $\nu(\text{C}-\text{N})$  vibrations respectively

and there is considerable couplings between these two modes of vibrations. Similar results were obtained by Suzuki<sup>2-4</sup> in case of acetamide and by the authors<sup>5</sup> in case of N,N-dimethylformamide and N,N-dimethylacetamide.

The bands at  $480\text{ cm}^{-1}$ ,  $243\text{ cm}^{-1}$  are assigned to the bending and rocking vibrations of



group and those at  $395\text{ cm}^{-1}$  and  $571\text{ cm}^{-1}$  to the rocking vibrations of  $(\text{C}-\text{C}_2\text{H}_5)$  group and  $(\text{O}=\text{C}-\text{N})$  bending vibrations respectively.

One of the authors (V. V. C.) is grateful to C.S.I.R., for the award of a Senior Research Fellowship.

1. Tatsuo Miyazawa, Takehiko Shimanouchi and Mizushima, S. I., *J. Chem. Phys.*, 1958, **24**, 408.
2. Isao Suzuki, *Bull. Chem. Soc. Japan*, 1960, **33**, 1360.
3. —, *Ibid.*, 1962, **35**, 540.
4. —, *Ibid.*, 1962, **35**, 1280.
5. Venkata Chalapathi, V. and Venkata Ramiah, K., *Proc. Ind. Acad. Sci.* (Under publication).
6. Venkata Ramiah, K., Venkata Chalapathi, V. and Indira Chai, C. A., *Curr. Sci.*, 1966, **35**, 350.

## MICRODETERMINATION OF CERIUM IN MARINE ENVIRONMENT \*

T. M. KRISHNAMOORTHY, V. N. SASTRY AND T. P. SARMA

Health Physics Division, Bhabha Atomic Research Centre, Bombay

THE distribution of trace elements between sea-water, sediments and biological species will aid in the understanding of the geochemical processes taking place in the sea. Since rare-earths belong to the group of elements dispersed in sea, the R.E. distributions together with other data is useful in the study of distribution of water masses in the oceans and in the solution of many geobiological problems. Due to the recent contamination of water masses by long-lived radioisotopes such as caesium-137, strontium-90 and cerium-144, etc., from bomb-explosions and discharges from nuclear installations, the study of rare-earths, especially cerium-144 distribution, is particularly important. Very little data are available of the distribution of R.E. in marine environment. The first measurements are that of Goldsmid<sup>1</sup>

and Balshov and Khitrov<sup>2</sup> on Indian Ocean waters. The procedure adopted by Balshov and Khitrov is for total rare-earth in sea-water samples only and there is a loss of about 5-25% of R.E. on activated charcoal. Goldberg<sup>3</sup> determined the concentrations of the rare-earths in the Pacific Ocean Waters, Manganese nodules and Phosphorite samples by activation analysis. It is the objective of this investigation to develop a uniform colorimetric method for the estimation of cerium in all the three matrices of the marine environment, viz., sea-water, sediments and biological samples and to use this method for determining the cerium content in the marine environment off West Coast of India.

The sea-water and sediment samples are collected from Tarapur region (Latitude  $19^\circ 45' \text{ N}$ , Longitude  $72^\circ 36' \text{ E}$ ) about 2-3 km. offshore. Most of the biological samples are collected from nearby regions.

\* This work is carried out under IAEA/BARC research Agreement No. 155/R3/CF.

About 60 litres of the sea-water samples are filtered through Whatman No. 42 filter-paper, acidified to a pH of about 2 with concentrated HCl. About 5 gm. of  $\text{FeCl}_3$  is added and precipitated as hydroxide by adding ammonia to carry down rare-earths. The solution is filtered and the precipitate is dissolved in concentrated HCl. The iron solution along with rare-earths is passed through Dowex-1 anion exchange resin previously conditioned with 10 N HCl. Washing the column is continued with 10 N HCl. The effluent and the leaches which are free from iron are reduced to a small volume of about 50 ml. 5–10 mg. of calcium as carrier is added and precipitated as oxalate at pH 5 at two different temperatures which carries down rare-earth oxalates along with small amounts of manganese. In the final procedure 10 mg. of calcium is added and precipitated as oxalate at room temperature (28–30° C.). The oxalate precipitate is filtered through Whatman No. 42 filter-paper and the precipitate is ignited at 600° C. for about 3–4 hours to decompose the oxalate. In order to remove manganese, the residue is dissolved in 2 N  $\text{H}_2\text{SO}_4$  and oxidised with potassium periodate to convert manganese to permanganate. 10 mg. of zirconium is added to the solution and zirconium precipitated as zirconium iodate. The effect of manganese decontamination is studied by taking 1 mg. of manganese and 10 mg. of zirconium and precipitating as zirconium iodate. The iodate precipitate is centrifuged and decomposed with  $\text{H}_2\text{SO}_3$  and then taken up in 8 ml. of 1 N  $\text{H}_2\text{SO}_4$ . 1 ml. of potassium persulphate solution (25 mg.) and 1 ml. of  $\text{AgNO}_3$  (0.5 mg.) are added and the solution gently boiled for about 5 minutes to oxidise cerous to ceric. The volume is made up to 10 ml. and its absorbance is measured at 350  $m\mu$  and also at 520  $m\mu$  to correct for traces of manganese accompanying cerium. 30 litres of artificial sea-water is spiked with 100  $\mu\text{g}$ . of cerium and the overall recovery of cerium by the above procedure is done in 2 samples and found to be about 75%.

The biological samples are ashed at 500° C. and the ash is digested with dilute HCl and centrifuged. The supernatant liquid is passed through Dowex-1 anion exchange resin as above and the further steps are followed as before.

Sediment samples are dried at 100–110° C. A known weight of the dried sample is leached

with N/20 HCl, 5% EDTA, 1 N ammonium citrate and 1 N ammonium acetate as described by Sarma *et al.*<sup>4</sup> The leaches are evaporated to dryness, muffled at 500° C. and then taken up in concentrated HCl. Further steps are similar to that followed for sea-water.

20–100  $\mu\text{g}$ . of cerium is taken and oxidised with potassium persulphate-silver catalyst and made up to 10 ml. The absorbances are measured at 320 and 350  $m\mu$  to get the calibration curves. The results are given in Fig. 1.

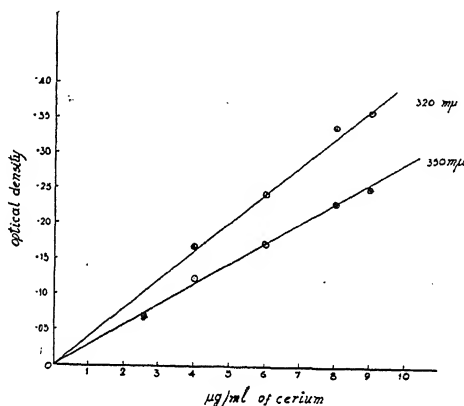


FIG. 1. Calibration curve for cerium.

Even though the sensitivity at 320  $m\mu$  is 0.025  $\mu\text{g./cm.}^2$  for 1 cm. path length for log  $I_0/I = 0.001$ , the actual measurements are made at 350  $m\mu$  with a sensitivity of 0.033  $\mu\text{g./cm.}^2$  in order to avoid higher blanks. Interferences due to similar elements such as La and Th are studied and found to be negligible upto 0.1 mg./ml. The interference due to zirconium carrier used in the procedure is also found to be negligible.

Table I gives the effect of temperature and the carrier concentration in the co-precipitation of cerium with calcium oxalate. It is seen from Table I that higher temperatures inhibit the co-precipitation of cerium. The recoveries of cerium are good when 10 mg. of calcium carrier is added and the experiments are carried out at room temperature (95 ± 5%). Five blank experiments on the recovery of cerium on zirconium iodate in presence of 1 mg. of manganese have been carried out and they give a value of 95 ± 5% as shown in Table II.

The sediment and biological species contain varying amounts of manganese and even though 99% decontamination is achieved in the zirconium iodate precipitation step, it is necessary to correct for any accompanying trace amounts

TABLE I  
Cerium co-precipitation with calcium oxalate

No.	Calcium carrier mg.	Temperature 28-30°C. absorbance of cerium		Cerium recovery %	Temperature 75-80°C. absorbance of cerium		Cerium recovery %
		Added OD	Obtained OD		Added OD	Obtained OD	
1	5	0.320	0.256	80	0.290	0.095	33
2	5	0.320	0.204	64	0.290	0.060	21
3	5	0.320	0.224	69	..	..	..
4	5	0.320	0.225	69	..	..	..
5	5	0.320	0.202	64	..	..	..
6	5	0.320	0.202	64	..	..	..
7	10	0.240	0.232	97	0.290	0.131	45
8	10	0.240	0.242	100	0.290	0.121	41
9	10	0.240	0.242	100	..	..	..
10	10	0.240	0.232	97	..	..	..
11	10	0.240	0.240	100	..	..	..
12	10	0.240	0.240	100	..	..	..
13	10	0.175	0.164	94	..	..	..
14	10	0.175	0.179	100	..	..	..
15	10	0.257	0.260	100	..	..	..
16	10	0.257	0.240	93	..	..	..

TABLE II  
Decontamination of manganese in co-precipitation of cerium with zirconium iodate

No.	Test solution	Absorbance of cerium at 350 m $\mu$			Accompanied manganese %	Cerium recovery %
		Added OD	Obtained OD	Net OD		
1	Reagent blank (Persulphate with Ag catalyst)	..	..	0.060	..	..
2	Reagent blank + 10 mg. Zn	..	..	0.060	..	..
3	Reagent blank + 10 mg. Zn + 1 mg. Mn	..	0.126	0.066	1.1	..
4	Reagent blank + 10 mg. Zn + 1 mg. Mn	..	0.130	0.070	1.2	..
5	Reagent blank + 10 mg. Zn + 1 mg. Mn	..	0.116	0.056	0.9	..
6	Reagent blank + 10 mg. Zn + cerium + 1 mg. Mn	..	0.160	0.270	0.150	1.1*
7	Reagent blank + 10 mg. Zn + cerium + 1 mg. Mn	..	0.160	0.270	0.150	1.1*
8	Reagent blank + 10 mg. Zn + cerium + 1 mg. Mn	..	0.175	0.290	0.170	1.1*
9	Reagent blank + 10 mg. Zn + cerium + 1 mg. Mn	..	0.175	0.295	0.175	1.1*
10	Reagent blank + 10 mg. Zn + cerium + 1 mg. Mn	..	0.175	0.292	0.172	1.1*

\* The contribution of Mn in cerium absorbance is taken as 1.1%, average of test solution Nos. 3, 4 and 5.

of manganese (as permanganate) for absorbance of cerium wavelength, 350 m $\mu$ . In order to achieve this, manganese standards are prepared in the range of 1-5  $\mu$ g./ml., oxidized with persulphate as earlier, and their absorbances are measured at 520 m $\mu$  and 350 m. These values are given in Fig. 2. The ratio of O.D. at 350 m $\mu$  to O.D. at 520 m $\mu$  is observed to be 0.5. In the actual samples, besides measuring the O.D. at 350 m $\mu$  for cerium, the measurements are also made at 520 m $\mu$ . From the absorbance obtained at 350 m $\mu$ , the contribution due to manganese is subtracted using the ratio from the graph.

In Table III are given the measured cerium content of sea-water, fishes and sediment leaches. The sea-water values obtained by us are agreeing with those obtained by Mauchline and Templeton<sup>5</sup> and Balshov and Khitrov.<sup>2</sup> In the biological samples analysed (Pomfret, Ghol, Cat-fish, Lobster and Sea-hare), the accumulation factors vary from 200 to 450 whereas Mauchline and Templeton<sup>5</sup> reported only a value of 12 for fishes. The HCl, EDTA and ammonium citrate leaches of sediments (average of 4 samples) are giving accumulation factors of about 20,000 whereas ammonium acetate leach is giving around 6000.

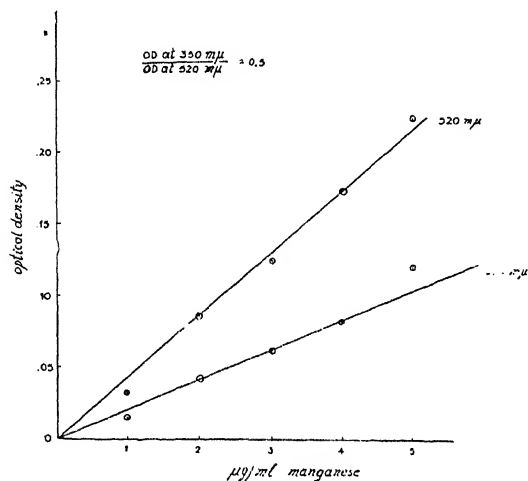


FIG. 2. Interference of manganese at 350 mμ.

TABLE III

Cerium content in different matrices of the marine environment off Tarapur Coast

No.	Sample	Cerium content ppm
1	Sea-water	.. $1.0 \times 10^{-3}$
2	Sea-water	.. $0.8 \times 10^{-3}$
3	<i>Arius</i> sp. (Cat-fish)	.. 0.20
4	<i>Pseudosciana dicanthus</i> (Ghol)	.. 0.38
5	<i>Pampus</i> sp. (Pomfret)	.. 0.38
6	<i>Panulirus polyphagus</i> (Lobster)	.. 0.32
7	<i>Aplysia</i> sp. (Sea-hare)	.. 0.40
8*	HCl leaches of sediment	.. 21.00
9*	EDTA leaches of sediment	.. 18.20
10*	Amm. cit. leaches of sediment	.. 21.00
11*	Amm. acet. leaches of sediment	.. 5.20

\* Average of four samples. Biological samples are expressed on wet weight basis whereas sediment samples are expressed on dry weight basis.

Some of the general conclusions that can be drawn out of this work are :

- The biological species accumulate large amounts of cerium,
- there is a large amount of labile cerium associated with sediments, and
- since EDTA and ammonium citrate are known to form strong complexes with rare-earths, similar values obtained for HCl, EDTA and ammonium citrate leaches is understandable.

We wish to express our deep appreciation to Dr. A. K. Ganguly, Head, Health Physics Division, Bhabha Atomic Research Centre, for initiating the work and his continued interest.

- Goldsmidt, V. M., "The principle of distribution of chemical elements in minerals and rocks," *J. Chem. Soc.*, 1937, p. 655.
- Balshov, A. and Khitrov, L. M., "The distribution of rare-earths in the waters of Indian Ocean," *Geochemistry, Eng. Trans.*, 1961, 1, 877.
- Goldberg, E. D. and Koide, M., "Rare-earth distribution in marine environment," *J. Geophys. Res.* 1963, 68, 4209.
- Sarma, T. P., Doshi, G. R., Gogate, S. S., Krishnamoorthy, T. M., Neralla, V. R., Rama Rao, M., Rao, S. R., Sastry, V. N., Shah, S. M. and Unni, C. K., "Geochemical investigations off Tarapur Coast," *J. National Institute of Sciences*, 1968 (In press).
- Mauchline, J. and Templeton, W. L., "Artificial and natural isotopes in the marine environment," *Oceanogr. mar. biol. Ann. Rev.*, 1964, 2, 229.

## MORPHOLOGY OF THE SHAGGY GLANDS OF *CLEOME VISCOSA* L.

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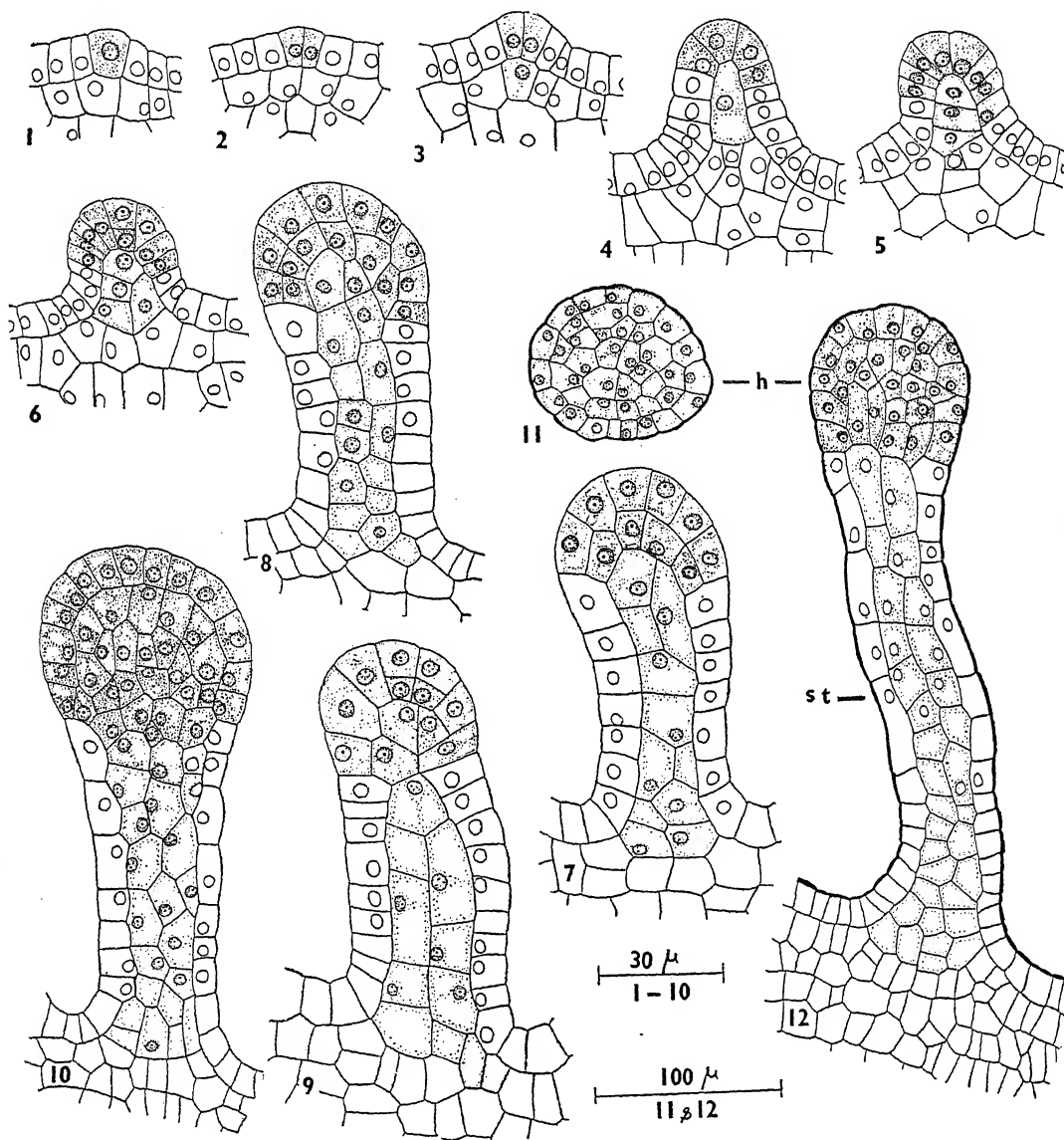
THOUGH plant hairs are well known for their taxonomic importance, a sustained use of these structures at all taxonomic levels has so far not come into practice. This is due to the fact that neither do we have authentic information about the total number of their types nor distribution in the vascular plants. Resume of mature trichome types occurring in

the different dicot families and several monocot groups have been given by Solereder<sup>9</sup> and others,<sup>1,2,10-12</sup> but one doubts if these could be taken as such, for typification in trichomes, particularly in the shaggy hairs, without a knowledge of their ontogeny, is not feasible. In a series of papers,<sup>3-7</sup> the first author has earlier dealt with the structure, development,

and principles of classification of trichomes of the Compositæ and suggested that trichomes of vascular plants in general may be similarly classified so that they could be utilised as an effective taxonomic tool.

Study of the mature trichomes is being pursued under our current project 'Flora of Hyderabad',<sup>8</sup> since this enables us to come into contact with a cross-section of angiosperms.

Ontogenetic studies are being undertaken



FIGS. 1-12. *Cleome viscosa* L. From L.S. developing ovary. For details of explanation see text.  
(st = stalk; h = head.)

In view of the above, in this laboratory, studies have been initiated to gain authentic information about mature trichome types on one hand and about their ontogeny, particularly of the shaggy hairs, on the other.

separately, of which the results of our findings on the shaggy glands of *Cleome viscosa* L. are communicated through this paper.

The shaggy glands are multiserial and consist of a stalk and a head, of which the



latter is secretory in nature (Fig. 12). They are 50–1000  $\mu$  in length and 25–100  $\mu$  in diameter and borne by the stem, leaf (on both the surfaces; absent on the veins towards the upper side), sepal (lower surface) and ovary. The largest forms are frequent on the stem and pedicel.

Right from the beginning, the two parts of the gland, the head and the stalk show their development from two independent sources. The head is initiated from a single protodermal cell (Fig. 1), while the stalk from both sub-protodermal and protodermal initials subtending the initial of the head (Figs. 3 and 4). The head initial is conspicuous by its larger size and dense cytoplasm (Fig. 1). First it divides longitudinally into two (Fig. 2); then the dyads divide again in the same manner (Fig. 3) but at right angle to the previous partition so that a tetrad of four juxtaposed cells is produced. This is recognised due to the fact that this stage is represented by two cells in consequent sections. The quadrants also again divide and redivide but anticlinally, as a result of which the head now appears many-celled in median sections (Figs. 4 and 5). By this time, it becomes raised above the rest of the epidermis due to development of the subtending emergence tissue (details given below). In further development the head cells divide periclinally and then in other planes (Figs. 6–10). Consequently it attains its characteristic hemispherical form, 5–6-celled in height (Figs. 10 and 12) and 6–8-celled in breadth (Figs. 11 and 12). The cells become increasingly denser and secretory.

The stalk differentiates along with the head, remaining distinctive until about maturation, whereupon the two appear relatively less delimited. The first sign of the stalk development is indicated by an enlarged cell subtending the head when the latter is 4-celled (Fig. 3). The stalk cell is conspicuous by its large size and dense contents, though relatively less so as compared to the overlying head cells. Soon it enlarges and multiplies through transverse and other divisions due to which the gland as a whole appears like a small protuberance. By this stage the protodermal cells subtending the head also start dividing anticlinally as

indicated from the recently formed cells characterised by narrow diameter seen in Figs. 4–6. It is, however, difficult to recognise as to how many tiers of the protodermal cells participate in contributing to the formation of the epidermis of the stalk. Further development of the stalk follows the same course as before, but the ground cells undergo more longitudinal divisions due to which it becomes 4–6-celled in breadth (Fig. 12.) Finally the cells of both the epidermis and the ground tissue of the stalk mature through vacuolation and axial elongation (Fig. 12).

From the ontogeny it is obvious that the shaggy glands of *Cleome viscosa* are composite structures and not mere hairy appendages as has been considered in the past.<sup>1-9</sup> The head is suggestive to be a trichome as it is derived from a single protoderm initial, whereas the stalk an emergence for it is produced from a primordium consisting of protodermal and sub-protodermal elements. Ramayya<sup>6</sup> has previously shown the occurrence of similar structures in several other plants. Since the initial of the trichome part undergoes more than one anticlinical division at the outset, according to the trichome classification proposed by Ramayya<sup>1</sup> it can be assigned to the P-multi-seriate trichome system.

#### ACKNOWLEDGEMENTS

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- 1 Metcalfe, C. R. and Chalk, L., *Anatomy of the Dicotyledons*, 1950, 1 & 2.
- 2 —, *Anatomy of Monocotyledons, I. Gramineae*, 1960.
- 3 Ramayya, N., *Bull. Bot. Survey India*, 1962, 4, 177.
- 4 —, *Ibid.*, 1962, 4, 189.
- 5 —, *Curr. Sci.*, 1963, 32, 27.
- 6 —, *Ibid.*, 1964, 33, 577.
- 7 —, *Plant Anatomy Symposium*, 1966 (In press).
- 8 — and Rajagopal, T., *J. Osm. Univ. Sci.*, 1968 (In press).
- 9 Solereder, H., *Systematic Anatomy of the Dicotyledons*, Clarendon Press, Oxford, 1908.
- 10 Stant, M. Y., *J. Linn. Soc. (Bot.)*, 1964, 59, 1.
- 11 Tomlinson, P. B., *Anatomy of the Monocotyledons. II. Palmæ*, Clarendon Press, Oxford, 1961.
- 12 Uphöf, J. C. Th., *Plant Hairs*, in K. Linsaberer, *Handbuch der Pflanzenanatomie*, 2nd Ed., 1962, and 4, Tiel. 5, Berlin.

## LETTERS TO THE EDITOR

SPECTRA OF NAPHTHALENE AND  
 $\alpha$ -,  $\beta$ -NAPHTHOL CATIONS IN  
BORIC ACID GLASS

THE electronic spectra of aromatic hydrocarbon anions have been experimentally observed and analysed by many workers<sup>1</sup> but only few appear to have reported the spectra of cations perhaps due to experimental difficulties.<sup>2</sup> Studies of Evans,<sup>3</sup> Hubert-Habart and Muel,<sup>4</sup> and Hoijsink *et al.*<sup>5</sup> show that the cations of aromatic hydrocarbons can be prepared by irradiating the solution of hydrocarbons in boric

were irradiated with UV light at about 110°C. and the spectra were recorded again.

After irradiation, the films became coloured. The colour persisted for months at room temperature but disappeared when the film was heated beyond 120°C. Apparently, on irradiation of the hydrocarbon in boric acid glass photoionization takes place, the electrons being captured in the glass. On heating, the glass softens and the electrons recombine with the ions. Figures 1-3 show the spectra of naphthalene and naphthols without irradiating

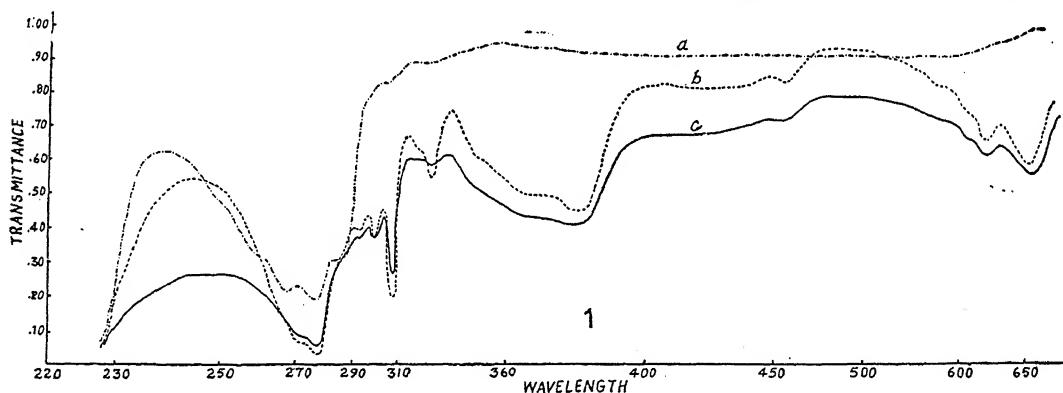


FIG. 1 Absorption curves of naphthalene ( $\sim 0.1\%$  by weight) in the boric acid glass (a) before irradiation (b) and (c) after irradiating with UV light for 3 and 60 minutes respectively. (Wavelength in  $m\mu$ .)

acid glass. In the present note we are reporting the electronic absorption spectra of naphthalene and  $\alpha$ -,  $\beta$ -naphthol cations in the 2200-7500 Å region.

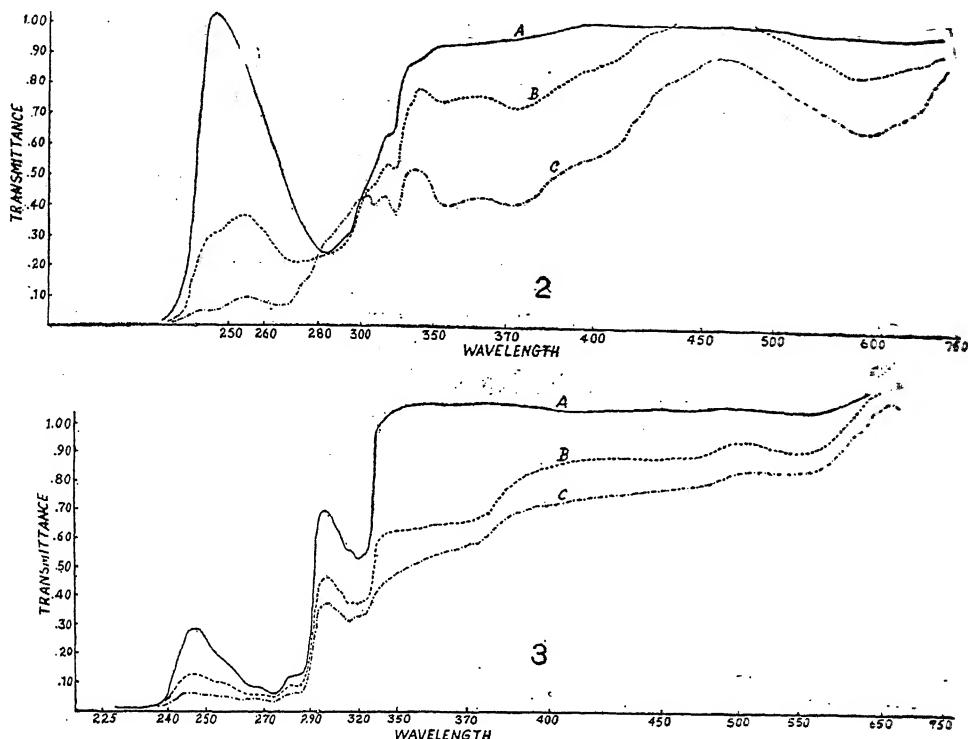
Boric acid of Analar grade (B.D.H.) was heated in a small pyrex vessel upto 240°C. and dehydrated till it lost approximately one molecule of water per formula weight. Then a small quantity of the hydrocarbon (0.1% by weight) was dissolved in the boric acid and the molten mass was quickly cast between two glass disks spaced about 0.5 mm. apart. After cooling to the room temperature the boric acid film was separated from the glass disks. A Perkin Elmer double beam spectrophotometer (Type 4000 Å) was used to record the spectrum of these boric acid films in the UV and visible regions. The films were irradiated at the room temperature with UV light from a 80-watt high pressure mercury lamp (the glass envelope of the lamp was removed) or with X-rays from a Philips X-ray unit, and the spectra were recorded. Finally, the films

and after irradiating the films. The positions of the principal band maxima along with their approximate visual intensities for the spectra of the cations are shown in Table I. The

TABLE I  
Principal band maxima of naphthalene,  
 $\alpha$ -naphthol and  $\beta$ -naphthol cations (in kK\*)

(Naphthalene)†	( $\alpha$ -naphthol)†	( $\beta$ -naphthol)†
15.0 vs	14.3 s	17.4 s
16.4 s	16.8 s	20.6 s
17.5 w	..	..
21.6 m	23.0 vw	22.1 m
23.5 vw d	24.6 w	25.0
26.3 s	26.8 s	26.7 s
27.2 w d	28.4 m	..
30.0 s	30.1 w	30.6 m
30.8 w	..	..
32.2 vs	31.0 s	31.2 s
33.2 m	32.5 m	31.9 s
33.9 w	..	..
36.0 vs	35.2 vs	35.1 m
36.6 s	37.3 m	36.4 s
..	..	37.6 m

\* kK=1000  $\text{cm}^{-1}$ , † vs—very strong, s—strong, m—medium, w—weak, d—diffuse.



FIGS. 2-3. Fig. 2. Absorption curves of  $\alpha$ -naphthol ( $\sim 0.1\%$  by weight) in the boric acid glass (A) before irradiation, (B) and (C) after irradiating with UV light for 3 and 60 minutes respectively. (Wavelength in m $\mu$ .) Fig. 3. Absorption curves of  $\beta$ -naphthol ( $\sim 0.1\%$  by weight) in the boric acid glass (A) before irradiation, (B) and (C) after irradiating with UV light for 3 and 60 minutes respectively. (Wavelength in m $\mu$ .)

spectrum of naphthalene cation is very similar to the spectrum of naphthalene anion, as expected theoretically.<sup>2,6</sup>

We would like to thank Professor Rais Ahmed for his continued interest in this work. One of us (Z. H.) acknowledges the hospitality of the Department of Chemistry, Delhi University, and the financial support of the University Grants Commission, India.

Department of Physics, ZAHID HUSSAIN.  
Aligarh Muslim University, B. N. KHANNA.  
Aligarh, May 23, 1968.

## SPECTROPHOTOMETRIC INVESTIGATIONS OF SOME METAL COMPLEXES OF OXIMIDOBENZOTETRONIC ACID

OXIMIDOBENZOTETRONIC ACID (OBTA) has already been reported as an analytical reagent<sup>1-6</sup> for the spectrophotometric and gravimetric determination of a number of metal ions. The present communication deals with spectrophotometric investigations on OBTA complexes with Mn(II), Fe(II) and (III), Co(II), Ni(II) and Cu(II).

Fresh alcoholic or acetone solutions of OBTA<sup>7</sup> were used. Stock solutions of Mn(II), Fe(II) (in presence of hydroxylamine hydrochloride), Fe(III), Co(II), Ni(II) and Cu(II) were prepared from B.D.H. (A.R.) or Merck (pro Analysis) Grade chemicals and standardized gravimetrically.

The pH of the solution was adjusted with dilute HClO<sub>4</sub> acid and NaOH solution and measured with Beckman pH meter model H-2.

1. Hinchcliffe, A., Murrell, J. N. and Trnajstic, N., *Trans. Faraday Soc.*, 1966, **62**, 1362.
2. Shida, T. and Hamill, W. H., *J. Chem. Phys.*, 1966, **44**, 2375.
3. Evans, D. F., *Nature*, 1955, **176**, 777.
4. Hubart-Habart, M. and Muel, B., *J. Chim. Phys.*, 1958, **55**, 377.
5. Bennema, P., van Voorst, J. D. W., Zandstra, P. J. and Hoijtink, G. J., *Mol. Phys.*, 1959, **2**, 431.
6. Hoijtink, G. J., Velthorst, N. H. and Zandstra, P. J., *Ibid.*, 1960, **3**, 533.

TABLE I  
Spectrophotometric characteristics of OBTA complexes with some metal ions

Metal ion taken	Colour of the complex	$\lambda_{\max}$ , m $\mu$	Molar extinction coefficient ( $\epsilon$ M) per mole metal	pH range where the complex is stable	Molar composition	Some properties of the complex
Mn (II)	Bluish-green	625	50 (a)	3.2- 5.7	1 : 1	Stable for only 10 min. Not extractable by $\text{CHCl}_3$ or $\text{C}_6\text{H}_6$
Fe (II)	Deep blue	625	$1.92 \times 10^4$ (a)	3.0-10.0	1 : 3	Extractable in $\text{CHCl}_3$ , but not in $\text{C}_6\text{H}_6$ and ether
Fe (III)	Greenish-blue	640-660	$6.8 \times 10^3$ (b)	3.0- 7.2	1 : 2	Extracted by $\text{CHCl}_3$ but not by $\text{C}_6\text{H}_6$
Co (II)	Green	405, 580	$1.4 \times 10^4$ , $2.9 \times 10^3$ (c)	..	1 : 1	Stable for only 10 min. in 95% acetone, unstable if >5% water is present
	Dark red	480	$1.32 \times 10^4$ (b)	10.2	1 : 2*	Not extracted by $\text{C}_6\text{H}_6$ or $\text{CHCl}_3$
	Yellow	410	$6.2 \times 10^3$ (d)	3.0- 6.1	1 : 3†	Neutral, extracted by $\text{CHCl}_3$ , $\text{CH}_2\text{Cl}_2$ , Ether, $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$ , etc.
Ni (II)	Yellow-brown	425	$3.2 \times 10^3$ (b)	4.2- 9.2	1 : 2	Stable for 15 min., extracted by $\text{CHCl}_3$ and $\text{C}_6\text{H}_6$
Cu (II)	Orange-brown	390-395	$6.3 \times 10^3$ (a)	2.3- 5.3	1 : 2	Stable for 30 min. Opalescence in solutions having 30% ethanol. Complex extracted by $\text{CHCl}_3$ and $\text{C}_6\text{H}_6$

(a)=40% ethanol; (b)=30% ethanol; (c)=95% acetone; (d)=60% acetone.

\* To prevent precipitation of Co (II) by hydrolysis at high pH, citrate ions (0.016 M) were added. Cobalt (II) does not form any mixed complex with OBTA and citrate ions.

† At lower ethanol or acetone concentration, a red-brown precipitate, which after drying at 120° corresponds to a 1 : 3 composition, is obtained. The complex is diamagnetic showing Co is in + 3 oxidation state.

Spectrophotometric measurements were made with Unicam spectrophotometer model SP 600.

The molar composition of the metal-OBTA complexes was determined by Job's method<sup>8</sup> of continuous variations as modified by Vosburgh and Cooper<sup>9</sup> as well as by the slope-ratio method.<sup>10</sup> The relevant data along with other characteristics of the complexes are given in Table I.

The stability constant ( $\beta_n$ ) of the metal-OBTA complexes was determined by (i) Harvey and Manning's method,<sup>10</sup> (ii) Foley and Anderson's method<sup>11</sup> and (iii) from Bjerrum's formation curves obtained spectrophotometrically<sup>12</sup> using Bjerrum's method<sup>13</sup> and correction term method.<sup>13</sup> The results are given in Table II.

The  $\text{pK}_a$  of the reagent was determined spectrophotometrically from the absorption spectrum of the reagent at different pH values as well as by a pH metric titration against NaOH, and was found to be  $3.50 \pm 0.05$  in 40% aqueous ethanol at 25° C. (ionic strength,  $\mu = 0.1$  mole, maintained by using  $\text{NaClO}_4$ ).

In Table II, it is observed that cobalt (II) gives 1 : 1 and 1 : 2 complexes with the reagent besides a 1 : 3 complex containing the metal in + 3 oxidation state, while in

TABLE II

Stability constants ( $\log \beta_n$ ) of OBTA-metal complexes at 25° C  $\pm$  2° C, ionic strength  $\mu = 0.1$  M ( $\text{NaClO}_4$ ) in 40% aqueous ethanol

Metal ions	Composition of the complex (Metal : OBTA)	$\log \beta_n$		
		Method (1)	Method (2)	Method (3)
Mn (II)	1 : 1	3.1	3.0	..
Fe (II)	1 : 3	14.0	13.5	13.7
Fe (III)	1 : 2	8.3	8.5	..
Co (II)	1 : 1	4.3 (a)	4.6 (a)	..
	1 : 2	6.5 (c)	6.9 (c)	..
Co (III)	1 : 3	15.8 (b)	15.4 (b)	16.2
Ni (II)	1 : 2	7.3	7.1	7.2
Cu (II)	1 : 2	9.4	9.2	9.1

(a)=95% acetone in absence of any  $\text{NaClO}_4$ ; (b)=60% acetone; (c)=in presence of 0.016 M Na citrate.

other cases only one complex has been detected. The order of stability constants for 1 : 2 complexes with bivalent metal ions (determined in 40% aqueous ethanol,  $\mu = 0.10$  mole) has been found to be  $\text{Co}^{+2} < \text{Ni}^{+2} < \text{Cu}^{+2}$ .

The authors thank Professor T. R. Seshadri for helpful discussions and the C.S.I.R., (India), for a Research Fellowship to one of them (G. S. M.).

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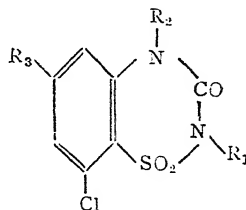
1. Bhat, A. N. and Jain, B. D., *Anal. Chim. Acta*, 1961, **25**, 343.
2. — and —, *J. Indian Chem. Soc.*, 1961, **38**, 779.
3. Manku, G. S., Bhat, A. N. and Jain, B. D., *Talanta*, 1967, **14**, 1229.
4. —, — and —, *Anal. Chim. Acta*, 1967, **39**, 128.
5. —, — and —, *Ibid.*, 1967, **39**, 369.
6. —, — and —, *Proc. Indian Acad. Sci.* (In press).
7. Anschütz, R., *Ann. Chem.*, 1909, **367**, 169.
8. Job, P., *Ann. Chim.*, 1928, **10** (9), 113.
9. Vosburgh, W. C. and Cooper, G. R., *J. Amer. Chem. Soc.*, 1941, **63**, 437.
10. Harvey, A. E. and Manning, D. L., *Ibid.*, 1950, **72**, 4488.
11. Foley, R. T. and Anderson, R. C., *Ibid.*, 1949, **71**, 909.
12. Anderson, R. G. and Nickless, G., *Anal. Chim. Acta*, 1967, **39**, 469.
13. Irving, H. and Rossotti, J. *Chem. Soc.*, 1953, p. 3397.

### SUBSTITUTED 1, 2, 4-BENZO- THIADIAZIN-3-ONES

DURING the course of our work on benzothiadiazines,<sup>1</sup> we had occasion to synthesize a few N-substituted o-aminobenzenesulphonamides. In view of the hypnotic and tranquilliser properties reported<sup>2</sup> for 2H-3, 4-dihydrobenzo-1, 2, 4-thiadiazin-3-one-1, 1-dioxides, the synthesis of the following 8-chloro- and 6,8-dichlorobenzothiadiazinones was undertaken.

The compounds listed in Table I were easily synthesized by heating the appropriate

(2 g.) and *n*-propylamine (4 ml.) were heated in a sealed pyrex tube for four hours at 140°. The reaction product was triturated with 2N hydrochloric acid. The residue (1.3 g.) was crystallised from benzene-hexane to obtain the title product; m.p. 125–26°. Found: N, 9.92; Calc. for C<sub>9</sub>H<sub>12</sub>Cl<sub>2</sub>N<sub>2</sub>O<sub>2</sub>S; N, 9.90%.



4-Propyl-6, 8-dichloro-2H-3, 4-dihydro-3-keto-1, 2, 4-benzothiadiazin-1, 1-dioxide.—2-propylamino-4, 6-dichlorobenzenesulphonamide (2 g.) was mixed thoroughly with urea (4 g.) and heated at 200° for four hours. The reaction product was cooled and triturated with dilute hydrochloric acid. The solid residue was taken up in 2N sodium hydroxide solution, clarified with carbon and acidified to obtain the crude title product (1 g.). It was crystallised from ethanol; m.p. 191–93. Found: N, 9.21; Calc. for C<sub>10</sub>H<sub>10</sub>Cl<sub>2</sub>N<sub>2</sub>O<sub>3</sub>S; N, 9.06%.

2-Methyl-4-phenylethyl-8-chloro-2H-3, 4-dihydro-3-keto-1, 2, 4-benzothiadiazin-1, 1-dioxide.—4-Phenylethyl-8-chloro-2H-3, 4-dihydro-3-keto-1, 2, 4-benzothiadiazin-1, 1-dioxide

TABLE I

No.	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	m.p. °C.	Nitrogen %	
					Found	Calc.
I	H	C <sub>3</sub> H <sub>7</sub>	H	188–89	10.31	10.20
II	H	C <sub>4</sub> H <sub>9</sub>	H	167–68	9.61	9.71
III	H	CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	H	214–15	8.51	8.68
IV	H	CH <sub>2</sub> CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	H	180–82	8.39	8.32
V	CH <sub>3</sub>	CH <sub>2</sub> CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	H	88–90	8.32	8.00
VI	H	C <sub>3</sub> H <sub>7</sub>	Cl	191–93	9.21	9.06
VII	H	CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	Cl	239–40	7.65	7.85
VIII	H	CH <sub>2</sub> CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	Cl	191–93	7.67	7.55

o-aminobenzenesulphonamide with excess of urea at 200° for 4–5 hours. Attempts to synthesize them by reacting the sulphonamides with potassium cyanate under neutral, alkaline or acidic conditions met with no success.

A few typical experiments are described below.

2-Propylamino-4, 6-dichlorobenzenesulphonamide.—2, 4, 6-Trichlorobenzenesulphonamide

(1.7 g.) was taken in 5% sodium hydroxide solution (60 ml.). Dimethyl sulphate (2.5 g.) was added to the former solution at 60° under stirring over 15 minutes. The reaction mixture was stirred and heated at 70° for 45 minutes and then cooled. The alkali-insoluble material (1.1 g.) was crystallised from aqueous ethanol to obtain the title product; m.p. 88–90°. Found: N, 8.32; Calc. for C<sub>16</sub>H<sub>15</sub>Cl<sub>3</sub>N<sub>2</sub>O<sub>3</sub>S; N, 8.00%.

Sarabhai Research Centre, S. SOMASEKHARA.  
Wali Wadi, Miss V. S. DIGHE.  
Baroda, May 11, 1968. S. L. MUKHERJEE.

1. Somasekhara, S., Dighe, V. S., Suthar, G. K., Dighe, N. K. and Mukherjee, S. L., *Ind. J. of Chem.*, 1968, **6**, 19.
2. Hurmer, R. and Vermin, J., *Fine Chem. Pat. Journal* (Brit. Patent 993273), 1965, **5** (25), 4.

### CARBONYL INSERTION REACTION ON CUPRIC ACETOACETIC ETHYL ESTER USING CARBONYL SULPHIDE

THE reaction of cupric acetoacetate ethyl ester with phosgene was reported to give 2:6 dimethyl 3:5 dicarbethoxy 1:4 pyrone.<sup>1</sup> We now report that the same reaction can be achieved by using carbonyl sulphide in place of phosgene. The former can be generated by the action of dil.  $H_2SO_4$  on potassium ethyl thiocarbonate (Bender's Salt).

#### EXPERIMENTAL

A solution of 0.025 mole of cupric acetoacetic ethyl ester in toluene (40 ml.) was taken and added to toluene containing excess of dissolved carbonyl sulphide. The tightly stoppered bottle containing the mixture was allowed to stand for about 48 hours with occasional shaking. The green colour due to the copper chelate gradually disappeared and a black precipitate of cupric sulphide was thrown out. The solution was filtered and then distilled. The residual viscous liquid on standing gave a very small amount of crystalline substance. This on recrystallization from benzene gave a pure compound with m.p.  $80^\circ C$ . Analysis C = 58.14; H = 6.05;  $C_{13}H_{16}O_6$  requires C = 58.2; H = 6.012.

The mixed melting point with an authentic sample of 2:6 dimethyl 3:5 dicarbethoxy 1:4 pyrone was undepressed. The very poor yield of the same may be due to incomplete cyclisation of the compound under the experimental conditions.

The authors wish to thank Dr. S. S. Deshpande for his keen interest in the problem and Dr. W. V. Bhagwat for facilities. Chemical Laboratories, P. NAGESWARA RAO.\* Holkar Science College, V. G. VAIDYA. Indore, M.P., April 23, 1968.

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1. Conard, M. and Guthzeit, M., *Berichte*, 1886, **19**, 22.

### INDUCTION OF DIPLOIDS IN FORCED HETEROCARYONS OF *ASPERGILLUS NIGER* VAN TIEGHEM

FUSION of two haploid nuclei produces a diploid. Attempts were made to induce diploids in forced heterocaryons of *A. niger* (Table I). These heterocaryons grew well and conidiated adequately on minimal medium<sup>1</sup> except HC-5 which grew but produced no conidia. They were incubated for a week at  $25^\circ C$ . on minimal medium with and without the treatment of diploid inducing agents.<sup>2</sup> Those presumed to be diploids in these experiments were those recovered and tested, by single spore culture, by measurement of conidial size, and by treatment of conidia with p-fluorophenyl-alanine.

The results showed that heterocaryon HC-3 and HC-4 produced diploids spontaneously whereas HC-1 and HC-5 required the treatment of a diploid inducing agent while HC-2 failed to produce diploid. HC-5 which did not conidiate in the original stage conidiated abundantly in the diploid stage. The single spore culture from each diploid appeared stable and similar to the wild type, except the HC-5 diploids. The latter culture was yellow rather than black indicating homozygosity for the colour marker. It was suggested by Roper (1952) that usually the size of diploid conidia was 1.3 times larger in diameter than the mean size of the parental conidia. This was (Table I) for the diploid of HC-3 and HC-4 whereas in HC-1 and HC-5 the ratio was 1:1.18, 1:1.08, respectively. When all the diploids were treated with p-fluorophenylalanine, they segregated into their parental components, thus proved that they were in fact true diploids.

These results suggest that diploid inducing agents may have very little effect in inducing diploids. Roper (1966) also reported that camphor vapour did not induce diploids in *Aspergillus* but rather selected out a higher proportion of natural diploid nuclei. It is suggested that when two dissimilar nuclei in heterocaryon divide synchronously they have greater opportunity to fuse and thereby form a diploid as is probable in case of HC-1, HC-3, HC-4, and HC-5. However, if they fail to divide synchronously it is difficult to produce diploid as is the case with HC-2.

The author wishes to express grateful appreciation to Prof. J. H. Burnett at the

TABLE I  
Conidial size of parent heterocaryons and induced diploids in *Aspergillus niger* and their comparative ratios

Heterocaryons No.	Symbol of Mutants	Conidial size of parents ( $\mu$ )	Conidial size of diploids ( $\mu$ )	Ratio of diploid conidial size to average of parental conidial size ( $\mu$ )
HC-1	gl paba $\times$ yl hypox	3.27 $\times$ 3.40 (3.33)*	3.92	1 : 1.18
HC-2	gl paba $\times$ yl hist	3.27 $\times$ 3.45 (3.36)	..	..
HC-3	gl meth $\times$ yl hypox	3.31 $\times$ 3.40 (3.35)	4.45	1 : 1.35
HC-4	gl meth $\times$ yl hist	3.31 $\times$ 3.45 (3.38)	4.57	1 : 1.35
HC-5	yl hypox $\times$ yl hist	3.40 $\times$ 3.45 (3.42)	3.72	1 : 1.08

\* Average of both parental conidial size.

University of Newcastle upon Tyne (England), for his guidance in this work.

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U.S.A., April 10, 1968.

1. Pontecorvo, G., Roper, J. A., Hemmons, L. M., Macdonalds, K. D. and Bufton, A. W., *J. Adv. Genet.*, 1953, 5, 150.
2. Roper, J. A., *The Fungi*, Edited by G. C. Ainsworth and A. S. Sussman, 1966, 2, 589.

### ISOLATION OF LUTEOLIN AND GLUCOLUTEOLIN FROM THE FLOWERS OF *TRIDAX PROCUMBENS*

*Tridax procumbens* Linn. (Family: *Compositae*) is a straggling herb bearing small yellow flowers found all over South India. Fresh flowers were collected during December-January, extracted thrice with methanol<sup>1,2</sup> by cold maceration and the total extract was concentrated *in vacuo* to a small volume. It was shaken with petroleum ether followed by ether. The ether extract on concentration yielded a yellow crystalline solid which after recrystallisation from methanol came out as yellow needles, m.p. 318-20. This was identified as luteolin by its  $R_f$  values on paper chromatography and preparation of its acetate, m.p. and mixed m.p. 224-26°. It was also compared with an authentic sample of luteolin. The ether extract left after the separation of luteolin indicated another spot on chromatography which had the  $R_f$  values of quercetin.

The aqueous layer on keeping in an ice-chest for 2 weeks deposited some light yellow crystalline solid which on recrystallisation from methanol-ether yielded pale yellow needles, m.p. 240-42° which was undepressed on admixture with an authentic sample of

glucoluteolin.<sup>3</sup> The glycoside on acid hydrolysis yielded luteolin and glucose. Hence it was identified as glucoluteolin. The mother liquor after removal of glucoluteolin was studied by paper chromatography and isquercetin could be identified by comparison of  $R_f$  values with those of an authentic sample.

A portion of the mother liquor was hydrolyzed with 7%  $H_2SO_4$  to yield quercetin, luteolin and glucose. The total yield of the pigment mixture was about 0.5% on the dry basis with a predominance of free luteolin.

The occurrence of luteolin and its 7-glucoside together with quercetin in *T. procumbens* is in agreement with earlier record on the distribution of flavonoids in the *Compositae*.<sup>4</sup>

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Medical Education A. G. R. NAIR.

and Research,

Pondicherry-6, April 26, 1968.

1. Pankajamani, K. S. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1953, 37 A, 720; *J. Sci. and Ind. Res.*, 1955, 14 B, 1.
2. Nair, A. G. R. and Subramanian, S. S. *J. Sci. and Ind. Res.*, 1961, 20 B, 507.
3. Subramanian, S. S. and Nair, A. G. R., *Indian J. Chem.*, 1964, 2, 338.
4. Harborne, J. B., *Comparative Biochemistry of Flavonoids*, Academic Press, 1967, pp. 226, 229.

### ON THE OCCURRENCE OF A HORN-CORE OF A BOVID IN THE RAJAHMUNDY SANDSTONES OF PANGADI, A.P.\*

THE present communication records the discovery of a portion of a horn-core of a bovid, presumably the first record of a vertebrate fossil, in the Rajahmundry sandstones at Chagallu (16° 59'; 81° 40'; 65 H/9), about 4 km., south of Pangadi, West Godavari District, Andhra Pradesh. A brief description of the horn-core is given below;

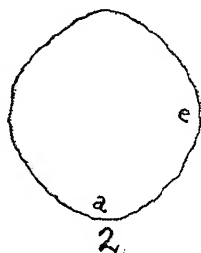
*Reduncinae* gen. indet. (cf. *Vishnucobus*) sp.  
[Figs. 1 and 2. (G.S.I. Type No. 18351)]

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Palaeontology Division,  
Southern Region,  
Hyderabad-28 (A.P.) India,  
November 28, 1968.

K. K. VERMA.  
D. P. MATHUR.



1



2.

FIGS. 1-2. *Reduncinae* gen. indet. (cf. *Vishnucobus*) sp.  
Fig. 1. Side view,  $\times 0.45$ . Fig. 2. Cross-section of the horn-core at the base,  $\times 1$ . a, Anterior side; e, External side.

The specimen (Fig. 1) comprises the lower portion of the horn-core, the basal margin of which is perhaps the broken-off level which fixed with the frontlet of the skull. It is broadly oval, tending to almost circular in cross-section (Fig. 2), which is maintained more or less throughout its preserved length. It is sculptured by prominent longitudinal ribs and furrows and has a backward curvature. Its anterior surface is convex and the posterior is concave. Judged from its uniform diameter, it was probably of considerable length. This configuration favours the authors to regard it as *Reduncinae*. Its size, shape and sculpture accords well with what might have been the case in the genus *Vishnucobus* Pilgrim.<sup>1</sup> Its measurements are as under:

Preserved length .. .. .	130 mm.
Antero-posterior diameter at the base .. .. .	31 mm.
Transverse diameter at the base .. .. .	29 mm.
Antero-posterior diameter at the extremity (incomplete) .. .. .	29 mm.
Transverse diameter at the extremity (incomplete) .. .. .	27 mm.

The authors are thankful to Shri C. Karunakaran, Deputy Director-General, and to Dr. K. N. Prasad, Geologist (Sr.), for their keen interest in this work.

\* Published with the kind permission of the Director-General, Geological Survey of India.

1. Pilgrim, G. E., *Pal. Indica*, 1939, 26 (1), 102.

### THE MALE OF THE ROTIFER *CUPELOPAGIS VORAX* (LEIDY)

A REVIEW of the previous literature shows that the males of rotifers have seldom been reported (see Hyman I). A passing reference to the male of *Cupelopagis* (= *Apsihus* Metschnikoff) was made by Metschnikoff<sup>2</sup> but his description lacks the details for the species on which studies have been made in this laboratory. The material for this study was collected on 7th March, 1967 from *Hydrilla* leaves from the Botanical Garden Tank of the Panjab University, Chandigarh, India. The temperature of the water of the tank was 18.5°C., and its pH value was 8.95.

The presence of mictic fertilized eggs in the pseudocoelom of the mictic females of *C. vorax* gave the first positive clue of the presence of males. In these females, one can easily distinguish between the fertilized and unfertilized eggs. The former are always enclosed in a thick brown cyst and remain dormant upto the next favourable season. The latter, however, continue to develop parthenogenetically in the uterus and hatch out as males. The fully developed male embryos were dissected out from these females and were kept for hatching in a cavity slab containing the filtered "culture water". These embryos hatched after a few hours and immediately started swimming actively. The male can be distinguished from the female by its reduced digestive tract and smaller size, i.e., nearly 1/10 of the size of the female.

The body of the male of *C. vorax* (Fig. 1) is cylindrical and is slightly broader in the middle. Its corona is circular and smooth. The margin of the corona is provided with a single wreath of cilia. The ciliated portion of the corona is supported by coronal matrix which is syncytial in nature. On the lateral side of the corona are present a pair of red-coloured eyes. Each eye gets its innervation directly from the brain. The brain is situated just behind the coronal tuft of cilia. The



reproductive system consists of a sacciform testis occupying only a portion of the pseudocoelom at the posterior end of the trunk.

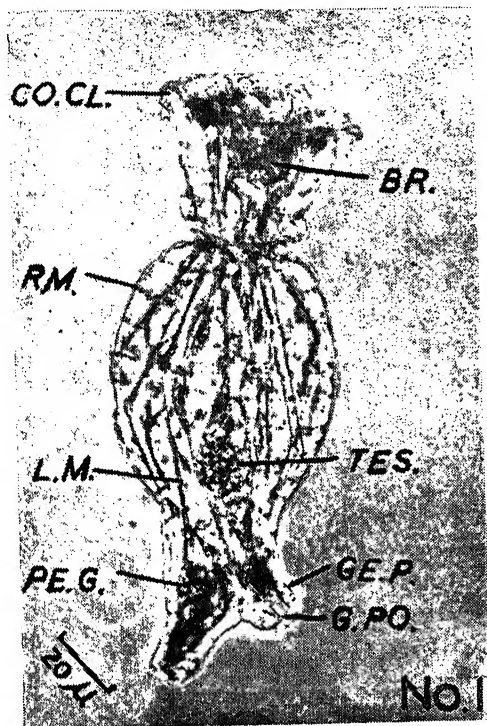


FIG. 1. A light micrograph of the male *Cupelopagis vorax* (Leidy) after supravital staining (slightly shrunk anteriorly due to contraction of a few ring muscles). BR., Brain; CO CL., Coronal cilia; GE.P., Genital papilla; G.PO., Genital pore; L.M., Longitudinal muscles; PE.G., Pedal gland; R.M., Ring muscles; TES., Testis.

A sperm duct from the testis proceeds to the genital pore. The muscular system of the male is represented by circular muscles (=ring muscles), longitudinal retractors and cutaneovisceral muscles. The pedal gland is a pear-shaped syncytial organ situated in the foot.

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# A NOTE ON THE OCCURRENCE OF 'SCHISTOSOME DERMATITIS' AT KONDAKARLA, ANDHRA PRADESH

DURING an investigation on cercarial fauna of snails in Kondakarla lake, situated 40 kilometers from Waltair, we encountered an instance where 'swimmer's itch' caused by the cercariae of *Schistosoma spindale* Montgomery, 1906, is prevalent. While the snails were being collected and washed in shallow water, peculiar itching sensation was felt on the submerged parts of the body. The itching sensation intensified with continued contact with water and collection of snails by wading had to be suspended. The snails were brought to the laboratory and upon isolation it was found that large number of brevifurcate, distomate, furcocercous cercariae were emerging from the common planorbid snail *Indoplanorbis exustus* Deshayes. A detailed examination proved that we are dealing with cercariae of the common bovine schistosome, *S. spindale*.

On the same day localised red swellings developed at the regions of irritation which persisted on the second day. Slight itching was persistent on the third day after collections and from the fourth day onwards the rash tended to disappear and was only faintly visible on the fifth day. The normal condition of the skin could be regained only at the end of the seventh day. In all persons who developed this 'schistosome dermatitis' the course of events was the same and in none of them any further developments like rise in temperature, etc., have been observed. In local people with repeated contacts with water it was usual to find on their hands and legs marks of persistent 'schistosome dermatitis'. Yet this does not seem to have received adequate attention as a Public Health Problem.

The measurements of the cercariae obtained in the present study are: (all measurements in millimeters) body 0.168-0.212  $\times$  0.048-0.068 (average 0.205  $\times$  0.059); tail stem length 0.244-0.30 (av. 0.272); furcal length 0.084-0.13 (av. 0.108); anterior penetrating organ 0.056-0.064  $\times$  0.03-0.034 (av. 0.06  $\times$  0.032); ventral sucker diameter 0.024.

*Schistosoma spindale* seems to be a very common parasite of cattle in South-East Asia and Africa. That the cercariae of this fluke cause 'schistosome dermatitis' has been reported by Buckley<sup>1</sup> from Malay Peninsula and by Anantaraman<sup>2</sup> from Madras State in India. The present record calls attention to

1. Hyman, L. H., *The Invertebrates*, McGraw-Hill Book Co., Inc., New York, 1951, 3.
2. Metschnikoff, E., *Ztschr. Wiss. Zool.*, 1866, 16.

yet another locality where 'swimmer's itch' caused by the larval forms of this fluke is of common occurrence.

Our thanks are due to Prof. P. N. Ganapati for his interest and encouragement. One of us (A. S. M.) thanks the authorities of the C.S.I.R. for the award of a Research Fellowship.

Department of Zoology, K. HANUMANTHA RAO.  
Andhra University, A. S. MURTY.  
Waltair; March 24, 1968.

1. Buckley, J. J. C., *J. Helminth.*, 1938, **16**, 117.
2. Anantaraman, M., *Indian J. Helminth.*, 1958, **10**, 46.

### ALKALINE PHOSPHATASE ACTIVITY IN THE OVARY OF *ANABAS SCANDENS* (CUVIER)

SEVERAL investigators have studied the alkaline phosphatase activity during embryonic development in various species of animals.<sup>1-5</sup> However, such studies on the differentiating tissues such as the growing ovaries of fishes have been sparse and sporadic.<sup>6,7</sup> An attempt is therefore made here to study the quantitative changes in the activity of alkaline phosphatase in the ovary during its growth in the case of *Anabas scandens*. The procedure of Kind and Macchi<sup>8</sup> for the extraction of enzyme and the method of Fiske and Subba Rao (cited by Hawk et al.<sup>9</sup>) for the determination of enzyme activity were followed.

tional differentiation of this enzyme. A sharp rise in the enzyme activity observed during early stages (II and III) of ovarian differentiation reaches its maximum in stage IV. This finding seems to be in agreement with the results obtained for the maturing ovaries of *Labeo*, *Mystus* and *Boleophthalmus* by Krishnamoorthy<sup>6</sup> and *Ophiocephalus* by Venugopalan.<sup>7</sup> It is interesting to note that in *A. scandens* the quantitative increase in enzyme activity coincides in time with the critical cytomorphological changes in the ovary. During stages II, III and IV, the oocytes grow rapidly by active synthesis and accumulation of substances like proteins and lipids.<sup>10,11</sup> A close correlation therefore exists between high enzyme activity and synthetic phase in the ovary. At fully mature stage (V), the level of enzyme drops; correspondingly, the protein and lipid syntheses in the ovary appear reduced as by this time the oocytes have completed their growth and differentiation. The low level of enzyme activity during stage VI signifies that the alkaline phosphatase apparently plays no prominent role during this stage.

One of us (N. H. G. D.) is grateful to the Government of India for financial support.

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Annamalainagar,  
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TABLE I

Quantitative changes in alkaline phosphatase activity in the ovary of *Anabas scandens* during its ovarian cycle. Expressed in  $\mu$  gm. 'P' liberated at 37° C. per 1 gm. of wet tissue

Stage of ovarian growth	I	II	III	IV	V	VI
	59.467±3.381	639.330±3.394	1291.733±4.121	1367.103±8.047	737.833±9.670	154.460±3.643

Oocytes being the chief components of the ovary, the six stages of the oocyte growth designated by Dutt and Govindan<sup>11</sup> would characterize the stages of ovarian growth in *A. scandens* (Table I).

Four aliquots per each growth-stage of the ovary from different fishes were assayed for the enzyme activity. In the stage I ovary alkaline phosphatase activity is low; characteristic of tissues in which there is no func-

1. Moog, F., *Biol. Bull.*, 1944, **86**, 51.
2. Brachet, J., *Experientia*, 1946, **2**, 1.
3. Krugelis, E. J., Nicholas, J. S. and Vosgian, M. E., *J. Exp. Zool.*, 1952, **121**, 489.
4. Løvtrup, S., *Acta Embryol. Morphol. Exp.*, 1958, **2**, 54.
5. Indira, T., "Biochemical and cytochemical studies during development and ovarian growth in *Sphaerodema molitum* (Duf.)," *Ph.D. Thesis*, Annamalai University, 1963.

6. Krishnamoorthy, K. P., *J. Zool. Soc. India*, 1959, **11**, 34.
7. Venugopalan, V. K., *Exptl. Cell Research*, 1961, **24**, 565.
8. Kind, C. A. and Macchi, M. E., *J. Cell. and Comp. Physiol.*, 1952, **39**, 153.
9. Hawk, P. B., Oser, B. L. and Summerson, W. H., *Practical Physiological Chemistry*, McGraw-Hill Book Company, Inc., New York, 1954.
10. Dutt, N. G. H., *Z. Mikr.-anat. Forsch.*, 1966, **74**, 179.
11. — and Govindan, P., *Ibid.*, 1967, **76**, 390.

#### A NOTE ON THE EXISTENCE OF EXOCORTIS VIRUS IN INDIA

TILL now the existence in India of two citrus virus diseases, viz., Tristeza complex and Greening has been experimentally proved.<sup>1,2</sup> In this note the existence of a new citrus virus disease, viz., Exocortis virus, is reported.

During periodical observations of the Musambi root stock trials laid out in the orchard of the Citrus Die-back Scheme, Shrirampur, bark of Rangpur lime (*Citrus limonia*, Osbeck) stock (Plant No. 10/13 of Replication II) bearing a top of Ganeshkhind Musambi (*C. sinensis*, Osbeck) was found to be scaled (Fig. 1). The scaling starts on the trunk from the bud joint and proceed downwards. This scaling is not accompanied with brown rot and gummosis caused by *Phytophthora* sp. Scaling of bark of Rangpur lime is the most prominent symptom of the disease caused by Exocortis virus. None of the other trees of Rangpur lime bearing a top of Musambi showed bark scaling.

With a view to establishing the existence of Exocortis virus in the tree under reference, it was indexed in November, 1966 on potted 1-year-old Rangpur lime seedlings grown in insect-free cages. Each pot contained four seedlings, three of which were inoculated with buds taken from the tree showing bark scaling and the fourth seedling was kept as control. Thus 12 Rangpur lime seedlings in four pots were bud-inoculated and the pots were kept for observations in the greenhouse of the scheme. Inoculated as well as uninoculated seedlings were cut back 20 days after inoculation and the new growth was observed periodically.

In April 1967, 6 of the 12 inoculated seedlings showed yellow patches on twigs followed by splitting of bark which ultimately scaled out. Deposition of gum was observed in places where bark had scaled out. These symptoms were similar to those observed by

Moreira<sup>3</sup> who demonstrated the use of Rangpur lime as a fast indicator of Exocortis virus. Not a single control uninoculated seedling developed the above-mentioned symptoms.



FIG. 1. Scaling of bark of Rangpur lime stock under natural condition.

Incubation period has been treated as the most important criteria for judging strains of the Exocortis virus. As the symptoms in the present experiment appeared within 135 days from the start of the experiment, the Exocortis virus reported here appears to be a severe strain of the virus.

Non-appearance of symptoms on the remaining 6 inoculated seedlings may either be due to (i) the buds used for inoculating these seedlings may not be carrying the virus or (ii) the buds may be carrying a mild strain, symptoms of which may appear after 8-10 months from the start of the experiment. A review of literature on Exocortis virus reveals that the virus may be distributed unevenly in the affected plant and that mild and severe strains of the virus can exist in one and the same plant.

The existence of Exocortis virus has pointed out dangerous potentials in the use of Rangpur lime or *Poncirus trifoliata* as rootstocks for sweet orange of this country without bud certification.

Citrus Die-back Res. Station,  
Shrirampur,  
September 9, 1967.

B. P. PATIL.  
D. C. WARKE.

TABLE I

Species	Habit	Pycnidia	Pycnidio- spores	Remarks
<i>S. minuta</i>	Sub-cuticular, Hemispherical	111-160 × 37-62 μ	4-5 × 0.8-1.2 μ	Dehiscence irregular
Indian species	Sub-epidermal, Shield shaped	117-285 × 38-60 μ	6-7 × 2-4 μ	Dehiscence by pore

1. Vasudeva, R. S. and Kapoor, S. P., "Citrus decline in Bombay State," *F.A.O. Plant. Prot. Bull.*, 1958, 6, 91.
2. Fraser, L. R., Daljit Singh, Kapoor, S. P. and Nariani, T. K., "Greening virus, the likely cause of citrus die-back disease in India" *Ibid.*, 1966, 14 (6), 127.
3. Moreira, S., "A quick field test for Exocortis, P-40-42," In W. C. Price (Ed.) *Proc. 2nd Conf. Intern. Organization Citrus Virol.*, Univ. Florida Press, Gainesville, 1961.

### SCHIZOTHYRA INDICA SP. NOV. A NEW RECORD FROM INDIA

A LEPTOSTROMATACEOUS fungus was recently collected by the writer growing saprophytically on dried bark of snake gourd (*Trichosanthes anguina* L.) from the crop museum of the Agricultural College, Poona (India) and which on examination was identified as a species of the form genus *Schizothyra* Bat. and Costa on the basis of the gross morphological characters. This fungus genus was established by Batista *et al.* (1957) with *S. minuta* as type collected on *Stigmatodothis caseariae* from Brazil. Besides, the genus is monotypic and has not been previously reported from India. This collection was, therefore, critically compared with the type species and found to be distinct from it, in respect of habit, morphological characters, dimensions and host relationship (*vide* comparative Table I).

#### *Schizothyra indica* GARUD SPEC. NOV.

Free mycelium lacking, pycnidia sub-epidermal, stromatic, scattered, uni-loculated, lenticular, carbonaceous, smooth, walls provided with an indistinct apical pore, 117-285 × 38-60 μ, epistroma black, uniformly thick, 15-22 μ, hypostroma 3-4 μ, conidiophores in wall layers, cylindrical, hyaline, 6-11 μ. Pycnidiospores 1-celled, hyaline, cylindrical, guttulate, 6-7 × 2.4 μ.

On dried bark of *Trichosanthes anguina* L., collected by A. B. Garud at Poona (India) on 15th December 1966, M.A.C.S. Herb. No. 405 (Type).

**Latin Diagnosis.**—Mycelio libero nullo, Pycnospormata sub-epidermate, sparsa, uniloculata, lenticular atra carbonica, glabra superior rimam poris dehiscences, 117-285 × 38-60 μ, paries superior carbonaceae continue 15-22 μ, paries inferior 3-4 μ, conidiophoreis in curtis cylindreus hyaline 6-11 μ, pycnidiosporae cylindraceus, gutulados, hyaline catenulate 6-7 × 2.4 μ.

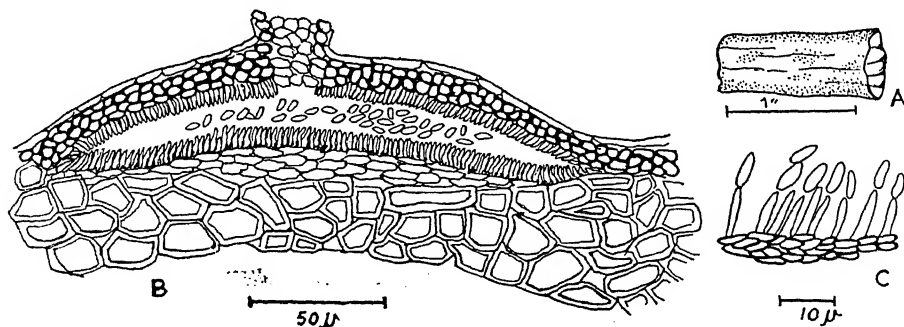


FIG. 1. A-C. A. Habit. B. Pycnidium with pycnidiospores. C. Pycnidiohores and pycnidiospores.

The Indian collection, in addition, is characterised by a sub-epidermal habit, lenticular nature of the pycnostroma and provision on an apical pore for dehiscence, which clearly distinguish this fungus from the type species thus meriting its accommodation in a new taxon.

The form genus *Schizothyra* Batista is a new generic addition to Indian fungi and the second known species of this form-genus.

The type material of this fungus is being deposited at M.A.C.S. Mycological Herbarium under No. 405.

Author's thanks are due to Prof. M. N. Kamat for his keen interest and guidance and Shri A. V. Sathe for help.

Maharashtra Association. A. B. GARUD.  
for the Cultivation of Science,  
Poona-4, October 13, 1967.

1. Batista, A. C., Amaral Costa, C. A. and Fernandes Vital, A., *Novos ou Raros Leptostromaceae Publ.* No. 82, Inst. de Micol. Univ. Recife (Brazil). 1957, pp. 399-411.

#### NOTES ON TWO *SYNCHYTRIUM* SPECIES ON VEGETABLE CROPS

I. DURING the *kharif* (July to September) season in the past few years, a fairly large acreage of cucurbitaceous crops such as *Luffa aegyptica* L. and *Luffa acutangula* Roxb. grown for vegetables was noticed suffering from rather an uncommon disease in the farmers' fields around Varanasi, U.P. Examination of diseased plants showed abundant development of small, warty or scabby swellings on the surface and deformity of the fruits and stunting of the shoots (Fig. 1). Initial symptoms of the disease appeared late in August on the creeping stem portions and leaf petioles lying in contact with the soil with the development of minute, hemispherical and translucent galls over the surface, when the creepers were in the preflowering stage. Gall development became intense and fast covering mainly the young shoots, flowering shoots as well as the young fruits. The leaves became thick and crinkled, leathery and brittle with reduced lamina and swollen petioles. All the young fruits touching the soil were atrophied, deformed and profusely covered with the infection galls. The infection on vines in the field ranged from 70 to 90%. Consequently, the entire produce in the infected fields was degraded in market value or was a total loss to the farmer.

Observations on serially cut sections of the infected host parts revealed presence of numerous thick-walled hyphospores (resting sporangia) underlying the hypertrophied tissues of the cortex and forming simple, dome-shaped galls. The orange-yellow, thick-walled, oval sporangia measured 65 to 150  $\mu$  in diam. Orange to amber-coloured sori were discernible in early developmental stages of the parasitic infection. The pathogenic fungus closely resembled *Synchytrium lagenariae* Mhatre and Mundkur in its morphological

characters and parasitism, to which it is referred.

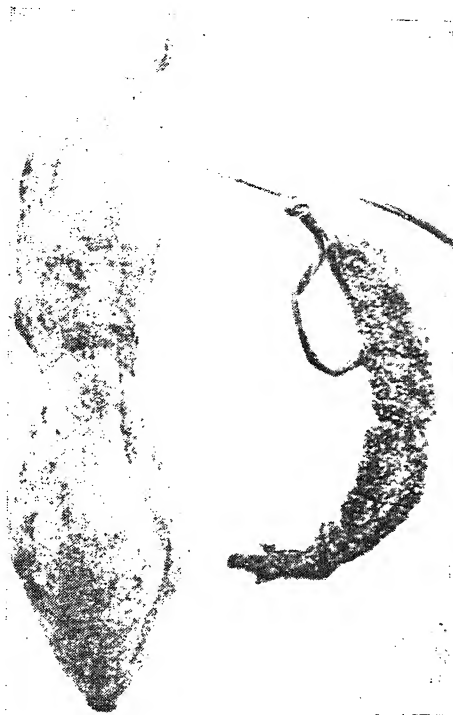


FIG. 1. Typical misshapen fruit of the host showing profuse gall development,  $\times \frac{1}{2}$  nat. size.

The chytridiaceous fungus has been reported on these hosts from several places in the Gangetic plains of North India as well as from the South and is being commonly observed in Varanasi. It is known to cover a wide host range in the family Cucurbitaceae.<sup>2</sup> It has been of negligible consequence so far and has not been reported to have taken a heavy toll of the crop as in the present case. The fungus has exhibited enough potentiality of being a serious menace to the crop in this area with the prevalence of favourable environment. Varanasi has an average annual rainfall of nearly 100 to 110 cm. (40 to 45 in.) evenly spread over July to September period, thus providing adequate free moisture for the spread of the parasite in wet fields. Obviously abundant free moisture and humid muggy weather with a high range of atmospheric temperature initiated the disease incidence predisposing the host. Prevalence of a period with a gradual drop in temperature and an even spell of moisture in the follow-up period appeared most conducive to speed up the attack and spread of the

disease during the fruiting period. This would necessitate further work to evaluate other aspects of its epiphytology and evolve adequate measures for its control.

II. A foliicolous species of *Synchytrium* was collected on the leaves of turnip (*Brassica rapa* L.) during a mycological survey tour at Darjeeling, West Bengal. The infection appeared as small hypophyllous, translucent, pale orange galls usually on the lower leaves. Infected leaves appeared dull due to pallor on the upper surface, although few of them were infected in a plant. No other host part was attacked and the loss in yield was apparently very insignificant. The infection was in scattered areas in the field and ranged between 5 to 10% by random count. Karling<sup>1</sup> in his extensive cross inoculation studies with *Synchytrium macrosporum* Karling found the fungus pathogenic on turnip also covering the latter within its host range. Morphology of the sorus galls and resting sporangia of our fungus broadly resembles the characters of *S. macrosporum*, to which it is referred tentatively. In that case, this constitutes the first record of its occurrence on this host in India.

*Synchytrium macrosporum* Karling in Sydowia, *Ann. Mycol.*, 1956, 10, 244.

Infection foliicolous, initially hypophyllous but amphigenous later in severe cases. Galls compositely monogallic, separate and scattered or crowded and confluent, mostly superficial, bright lavender red or often dark brown. Resting sporangia solitary, sometimes upto 5 in a gall, ovoid to ovate, 52.5 to 105  $\mu$   $\times$  37.5 to 95  $\mu$  or spherical 50 to 112.0  $\mu$  in diam. with a dark amber reddish-brown epispore 2.5 to 5  $\mu$  thick.

On living leaves of *Brassica rapa* L. at Darjeeling, W.B. on 10 October, 1963. Leg. S. L. Singh.

College of Agriculture, S. L. SINGH.  
Banaras Hindu University, M. S. PAVGI.  
Varanasi, October 16, 1967.

1. Karling, J. S., "Inoculation experiments with *Synchytrium macrosporum* Sydowia," *Ann. Mycol.*, 1960, 14, 138.

2. —, *Synchytrium*, Academic Press, New York, 1960, p. 470.

# ASSOCIATION OF PHOMA SP. WITH SORDARIA PAPILLOSA BAYES.

DURING a recent collection tour to Darjeeling the authors recorded severe leaf spots on *Talauma hodgsoni* Hook. f. and Thoms. The diseased leaves manifested light buff apical or marginal spots. Microscopic examination of the infected patches showed the presence of a species of *Phoma* as well as perithecia of an ascomycetous fungus. Isolations from the diseased leaves yielded a species of *Phoma* in culture. After about a month perithecia of *Sordaria papillosa* Bayes. were also developed in the same culture tubes.

In order to establish the relationship, in these two organisms, monoconidial and mono-ascospore cultures were raised and both the stages were found to be produced in a single culture tube.

*Phoma* stage is characterized by having the following morphological characters:

Mycelium light brown, richly branched, closely septate, 2.4–3.8  $\mu$  wide; pycnidia globose to sub-globose, light yellow, ostiolate, wall persistent, membranous, 42.2–92.4  $\mu$  (average 82.4  $\mu$ ); conidia oval to slightly elongated, hyaline, 3.8–5.7  $\times$  2.4–3.2  $\mu$  (average 4.2–2.6  $\mu$ ).

The culture was sent to C.M.I., Kew, but it could not be assigned to any of the existing species of *Phoma* so far. Species of *Phoma* and *Phyllosticta* have been found to be associated with several ascomycetous fungi including *Pleospora*,<sup>2</sup> *Mycosphaerella*,<sup>7</sup> *Venturia*,<sup>6</sup> *Guignardia*,<sup>5</sup> *Leptosphaeria*<sup>4</sup> and *Pleosphaerulina*,<sup>1</sup> etc., but its association with *Sordaria papillosa* has been noted for the first time.

The authors are thankful to Dr. G. C. Ainsworth and Dr. Booth of C.M.I., Kew, for their valuable help.

Department of Botany, J. L. SHREEMALI.  
University of Jodhpur, K. S. BILGRAMI.  
Jodhpur, May 4, 1968.

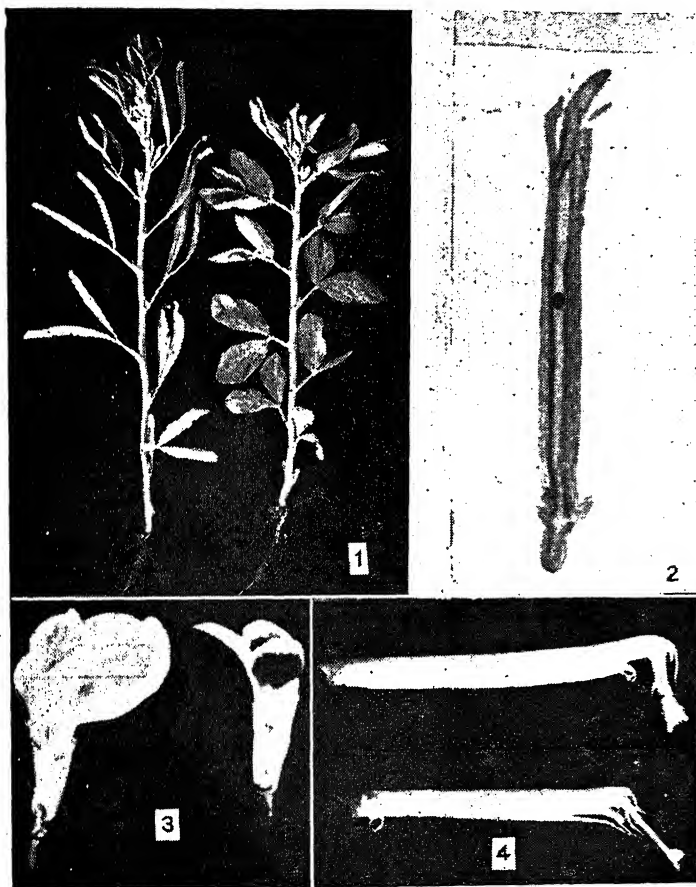
1. Abramoff, I. N., Pamphlet issued by far Easter, Plant Prot. Stat., Vladivostack, 1931, p. 120.
2. Bilgrami, K. S., "Association of a new species of *Phoma* with *Pleospora herbarum* (Pers.) Rahb.," *Curr. Sci.*, 1963, 32, 174.
3. —, "A note on the perfect stage of *Phyllosticta cycadina* (Pass.)," *Ibid.*, 1960, 29, 227.
4. Bourne, B. A., *Florida Agric. Exp. Stat. Tech. Bull.* 1934, 76, 267.
5. Davis, B. H., *Mycologia*, 1946, 38, 40.
6. Tengwall, T. A., *Phytopath. Lab. Willie. Commolin Schotten Baarn (Holland)*, 1924, 6, 58.
7. Wolf, F. A., *Mycologia*, 1940, 32, 331.

## FEMALE STERILITY IN BROAD BEANS (*VICIA FABA* L.)

BOND AND HIS CO-WORKERS<sup>1</sup> described a type of male sterility in broad beans which segregated as a simple mendelian recessive. Further they reported another form of male sterility involving cytoplasmic inheritance.<sup>2</sup> To the best of our knowledge, there has been no reports of female sterility in this plant.

Broad beans is an important food crop in the Sudan. It is grown as a winter crop; mainly in the Northern Province.

pollen grains were quite normal as indicated by aceto-carmin, cotton blue and germination tests. Cross-sections in the ovary at the early stages of development revealed the presence of four ovules while at flowering there was only one ovule (Fig. 2) which was apparently non-functional. Obviously there was breakdown of the ovules at early stages of development. In addition, there were some abnormalities in the other floral parts. The standard was much reduced and the stigma carried less hairs than in the normal plants (Figs. 3 and 4). When the keel was removed,



FIGS. 1-4. Fig. 1. "Narrow-leaf" plant (left) and a normal plant. Fig. 2. C.S. in the ovary (at flowering) showing a single ovule. Fig. 3. Flowers of a "narrow-leaf" plant (right) and a normal plant showing reduced standard in the former. Fig. 4. Reproductive organs of a "narrow-leaf" plant (above) and a normal plant.

A single plant with comparatively high number of pods was selected from a large field of broad beans. Among the progeny of this plant few individuals had narrow leaves (Fig. 1) and did not produce pods. The

the style appeared less bent than in the normal plants (Fig. 4). This was due to the fact that the two petals of the keel were free at the upper part while they were united in the normal flower. Preliminary cytological studies



made in P.M.Cs. of the "narrow-leaf" plants revealed no meiotic abnormalities.

The female sterility and narrow-leaf character proved to be recessive and there was indication of a single gene control. It seems that the two characters are either controlled by a single pleiotropic gene or else by very closely linked genes. Further studies on the nature of the genetic control are underway.

Faculty of Agriculture,  
University of Khartoum,  
Khartoum N., Sudan,  
May 4, 1968.

M. OSMAN KHAIR.  
T. M. TAHA.  
A. MUTWAKIL.

1. Bond, D. A., Drayner, J. M., Fyfe, J. L. and Toynbee-Clarke, G., *J. Agric. Sci.*, 1964, **63**, 229.
2. —, Fyfe, J. L. and Toynbee-Clarke, G., *Ibid.*, 1965, **66**, 359.

### HAUSTORIA IN *TAPHRINA* *MACULANS* BUTLER

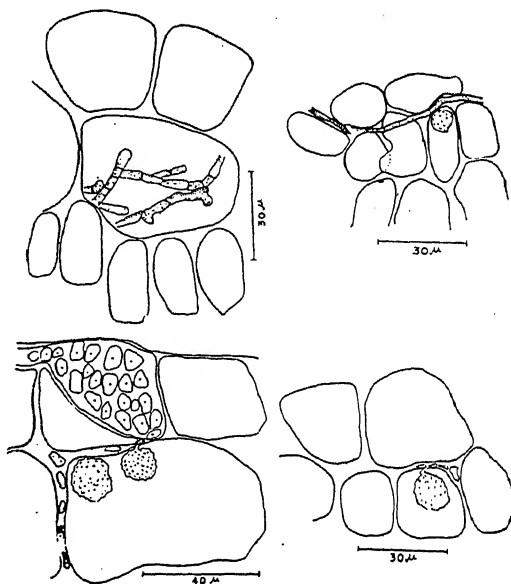
*Taphrina maculans* is a typically tropical species which has not received much attention till very recently since it was first described by Butler (1911).<sup>1</sup> The fungus infects leaves of *Curcuma longa* producing yellowish-brown blisters on both the surfaces of leaves.

Examination of sections revealed, in young stages of development, intercellular mycelium which is septate branched and uniformly dikaryotic (Fig. 2). The mycelium occasionally was found to become intracellular (Fig. 1).

The most striking feature of this parasitic mycelium on *C. longa* was the production of numerous, large, characteristic haustoria. These were found chiefly in the epidermal cells during the growing stage of the host. The haustoria were found to be equally numerous in the hypodermal cells. Such haustoria were first reported by Butler (1911)<sup>1</sup> in this fungus without any detailed account on their occurrence and structure. The haustoria were found to infect the epidermal, hypodermal as well as mesophyll cells (Figs. 3 and 4) but were more common in the first two regions. Vascular bundles were unaffected.

These haustoria arise from the intercellular hyphae, and consist of densely intertwined masses of hyphal strands arising through repeated divisions of the haustorial primordia ultimately assuming nearly solid globular structures giving a highly convoluted appearance (Figs. 3 and 4). The haustoria measure 8-14  $\mu$  in diam. Butler (1911)<sup>1</sup> has reported

the rare occurrence of similar haustoria in *Zingiber casumunar* infected by *T. maculans*. Production of haustoria has not been so far reported in any other species of *Taphrina*.



FIGS. 1-4. Fig. 1. Intracellular mycelium in a hypodermal cell. Fig. 2. Intercellular mycelium and a haustorium in mesophyll (spongy) tissue. Figs. 3-4. Haustoria in hypodermal and spongy parenchyma cells.

The author expresses her sincere thanks to Prof. M. N. Kamat for his interest and guidance.

M.A.C.S. Laboratories, ALAKA CHIPLONKAR.  
Poona-4, April 18, 1968.

1. Butler, E. J., "Leaf spot of turmeric (*Taphrina maculans* sp. nov.)," *Ann. Mycol.*, 1911, **9**, 36.

### A NEW SPECIES OF *SONERILA* ROXB. (MELASTOMATACEAE)

*Sonerila corneri* Nayar sp. nov. Habitu similis *S. kinabaluensis* Stapf, sed foliis basi attenuatis, venulis transversalibus indistinctis, petiolis brevioribus differt (Fig. A.)

*Herba* erecta, 20-30 cm. alta. *Caulis* quadrangularis vel subquadrangularis, farinosus. *Folia* subæqualia, elliptica, 4-10 × 1-4.5 cm., basi attenuata, apice acuminata, margine remote serrulata, supra glabra, subtus parce farinosa vel glabra, chartacea; petiolus 5-10 mm. longus. *Inflorescentia* terminalis vel axillaris, 3-8 flores; pedunculus 2-2.5 cm. longus, glaber, rubescens. *Calycis* tubus campanulatus, 8-9 × 2-2.5 mm., glaber, rube-



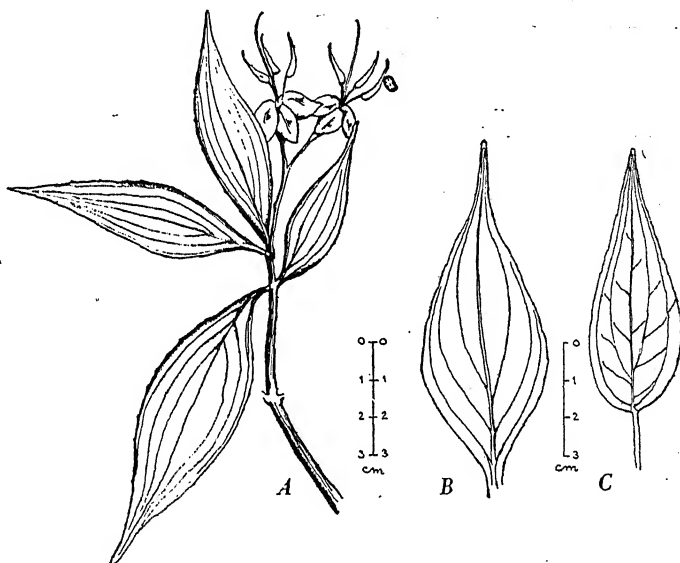
scens, 3-dentatus, dentibus triangularibus 1 mm. longis. *Petala* 3, ovato-elliptica, 10-12 × 4-5 mm., punicea (teste collectore). *Stamina* 3, filamentis 6-7 mm. longis, antheris lanceatis, 9 mm. longis, connectivo inappendiculato. Ovarium calycis tubo fere adhaerens, 3-loculare; stylus filiformis, 12-13 mm. longus glaber, rubescens, stigmatibus punctiformi. *Capsula* 7-8 mm. longa, pedicellus 4-6 mm. longus. *Semina* minuta, cuneata, numerosa, 0.4-0.5 mm. longa.

Typus lectus a Chew, Corner et Stainton ad locum Mt. Kinabalu, altit. 1500 m. in Sabah, Borneo die 9 Junius 1961, et positus in Herb. Kew, Anglia, subnumero *Chew, Corner et Stainton* (R.S.N.B. No.) 1002.

style filiform, 12-13 mm. long, glabrous, becoming red, stigma punctiform. *Capsule* 7-8 mm. long, pedicel 4-6 mm. long. *Seeds* minute, cuneate, numerous, 0.4-0.5 mm. long.

*Distribution*.—Borneo: Sabah, Mt. Kinabalu, alt. 1500 m., 9 June 1961, *Chew, Corner and Stainton* (R.S.N.B. No.) 1002. (Holotype K.)

*S. corneri* Nayar is allied to *S. kinabaluensis* Stapf in the nature of habit. However in *S. corneri* the leaf is shortly petioled (0.5-1 cm. long), leaf-base is attenuate and the cross-venules are indistinct (Fig. B); Whereas in *S. kinabaluensis* the leaf is long petioled (1.5-3 cm. long), the leaf-base is truncate and the cross-venules are distinct (Fig. C).



FIGS. A-C. Fig. A. Habit of *Sonerila corneri* Nayar. Fig. B. Leaf of *Sonerila corneri* Nayar. Fig. C. Leaf of *Sonerila kinabaluensis* Stapf.

Herb erect, 20-30 cm. in height. Stem quadrangular or subquadrangular, farinose. *Leaves* subequal, elliptic, 4-10 × 1-4.5 cm., base attenuate, apex acuminate, margin distantly serrulate, upper surface glabrous, under surface sparsely farinose or glabrous, chartaceous; petiole 5-10 mm. long. *Inflorescence* terminal or axillary, 3-8 flowered; peduncle 2-2.5 cm. long, glabrous, becoming red. *Calyx* tube campanulate, 8-9 × 2-2.5 mm., glabrous, becoming red, 3-dentate, lobes triangular, 1 mm. long. *Petals* 3, ovate-elliptic, 10-12 × 4-5 mm., pink (ex collector). *Stamens* 3, filament 6-7 mm. long, anther lance-shaped, 9 mm. long, connective inappendiculate. *Ovary* nearly adnate to the calyx tube, 3-chambered;

This species is one of the attractive *Sonerilas* of Malaysia, since the flowers are with the petaloid peduncle, calyx and style, pink petals and yellow stamens. The species is named in honour of Prof. E. J. H. Corner, F.R.S., for the contributions he has rendered to the understanding of tropical flora.

I wish to express my gratitude to Sir George Taylor, Director, Royal Botanic Gardens, Kew, U.K., for all facilities. My thanks are also due to the Rev. Fr. Dr. H. Santapau and Dr. K. Subramanyam for encouragement.

Industrial Section,  
Indian Museum,  
Botanical Survey of India,  
Calcutta-13, April 25, 1968.

M. P. NAYAR.

# **POLLEN ABNORMALITIES IN CASSAVA** (*MANIHOT ESCULENTA* CRANTZ)

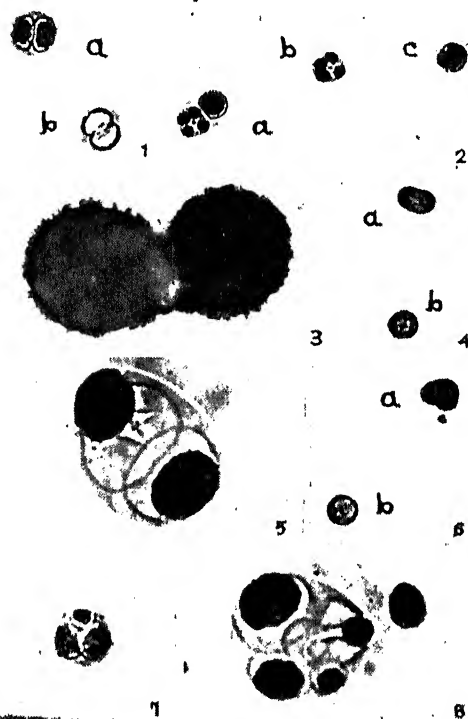
DEVIATIONS from the normal mode of microspore formation have been recorded in recent years in a number of plants. During the course of cytological studies conducted in the wide indigenous and exotic collections of Cassava maintained at the Central Tuber Crops Research Institute, Trivandrum, microspore sacs were observed with two, three and even upto five spores in addition to the normal tetrad associations. Such abnormal microspore formations are reported by Narayanaswami<sup>1</sup> in *Echinochloa*, Joshi<sup>2</sup> in *Osyris*, Singh<sup>3</sup> in *Viola*, Magoon *et al.*<sup>4</sup> in *Solanum* and by several others.

Normally each microspore mother cell in Cassava plants gives rise to four microspores in the form of a tetrad but occasionally fewer than four or more than four spores were observed to arise from a single pollen mother cell (Figs. 1-8). Monads, dyads and triads arise as a result of the formation of "restitution nucleus" after the first or second meiotic division, or the failure of one meiotic division or due to an irregular wall formation giving rise to one binucleate and two uninucleate spores. Formation of more than four spores (i.e., polyspory) usually results from the occurrence of lagging chromosomes which form micronuclei and give rise to sterile pollen grains of variable size. However, polyspory observed here seems to be due to division of the members of a tetrad as it can be seen in Fig. 8 that out of five microspores within the microspore sac one is large, two medium and equal in size while the remaining two are also of equal size though relatively much smaller than others. The latter spores have apparently resulted as a division of one of the spores in the normal tetrad.

Cytologically, meiosis in such microsporocytes is almost regular with 18:18 separation except for occasional unassociated chromosomes left at the metaphase I stage as univalents. Chromosome counts in the individual spores of a polyad could not so far be determined. Thus the situation as reported by Mahabale and Chennaveeriah<sup>5</sup> in *Hyphaene* seems to be more exacting in Cassava than observed by Tandon and Bali<sup>6</sup> in *Lantana* where polyspory has been attributed to irregular chromosome associations.

On the other hand, monad (Fig. 2a), dyad (Figs. 1, 5) and triad (Fig. 6a, 7) were also observed. Dyads normally arise as a result of failure of the archesporial nucleus to complete

division after the chromosome split. The second division may then proceed normally and produce dyads of spores. These could also result from the fusion of the metaphase plates at second division. If restitution takes place in these cells during the course of second division, a monad would result. Thus monads are much bigger in size (Fig. 2a) than the normal spores (Fig. 2b).



FIGS. 1-8. Fig. 1. a—Fertile and b—Sterile dyads,  $\times 300$ . Fig. 2. a—Normal tetrad and a monad, b—single normal tetrad and c—Twin pollen,  $\times 150$ . Fig. 3. Mature twin pollen with columella on exine,  $\times 405$ . Fig. 4. a—Twin pollen and b—Normal pollen,  $\times 180$ . Fig. 5. Dyad pollen at the bursting stage,  $\times 675$ . Fig. 6. a—Triad and b—Normal pollen,  $\times 90$ . Fig. 7. Triad pollen,  $\times 450$ . Fig. 8. Pentad pollen at the bursting stage,  $\times 675$ .

Furthermore, the irregular wall formation during the meiotic division may give rise to one binucleate spore, occasionally taking the shape of a twin pollen (Figs. 2c, 3 and 4a), and two uninucleate spores. Fertility in the dyads is quite variable. Both of these spores may either be fertile (Fig. 1a), sterile (Fig. 1b) or half sterile and half fertile as evidenced by their stainability with acetocarmine.

Double pollen grain is reported by Sanwal<sup>7</sup> in *Gnetum gnemon*. Cytological preparations in the double pollen grains of Cassava have

shown 18:18 separation of chromosomes in the two halves. Thus it is clear that these pollen grains are diploids in chromosome make-up. Similarly triads also arise due to the formation of a "restitution nucleus" and irregular wall formation.

All of these abnormal pollen grains could be seen even within the same anther.

The authors wish to acknowledge their sincere thanks to Dr. M. L. Magoon, Director, for giving us all necessary facilities.

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1. Narayanaswami, S., *Phytomorph*, 1955, 5, 161.
2. Joshi, P. C., *Ibid.*, 1960, 10, 239.
3. Singh, D., *Palynol. Bull.* II & III, 1960, p. 23.
4. Magoon, M. I., Cooper, D. C. and Hougas, R. W., *Amer. Jour. Bot.*, 1958, 45, 207.
5. Mahabale, T. S. and Chennaveeriah, M. S., *Phytomorph.*, 1957, 7, 184.
6. Tandon, S. L. and Bali, P. N., *Ind. Jour. Hort.*, 1955, 12, 1.
7. Sanwal, M., *Phytomorph.*, 1962, 12, 243.

### CYTOLOGICAL INVESTIGATION ON *KALLSTROEMIA PUBESCENS* (DON) DANDY

THE present study was undertaken to gain information on the cytology of *Kallstroemia pubescens* (Don) Dandy of the family Zygo-phylaceæ.

The plants were collected from Dum Dum, 24-Parganas (W. Bengal) and grown in pots. For karyotype analysis healthy root tips were pretreated in a saturated solution of para-dichlorobenzene for 2 hours at 15° C., stained in 2% aceto-orcin and (N) HCl mixture (9:1) for overnight and squashed in 45% acetic acid. For meiotic study flower-buds were fixed in acetic alcohol (1:2) for 24 hours and pollen mother cells were smeared in 1% propiono-carmin. Slides were made permanent in euparal and figures were drawn at a magnification of  $\times 2500$ . Voucher specimen (Datta, 10544) has been deposited in the herbarium of Central Botanical Laboratory, Calcutta.

Thirty-two chromosomes are present in the somatic complement (Fig. 1). They are

medium to short in size. Depending on the morphology and size differences, they can broadly be classified into the following types:

- Type A: One pair of medium-size chromosomes having two constrictions, primary and secondary, one median and the other sub-median in position.
- Type B: Nine pairs of medium to short chromosomes with sub-median primary constrictions.
- Type C: Six pairs of medium to short chromosomes with median primary constrictions.

Idiogram (Fig. 1a) of the somatic chromosomes indicates that they are graded in size ranging from  $1\mu$  to  $2.4\mu$ . Size difference of chromosomes is not marked.

Meiosis is regular with 16 bivalents at diakinesis and metaphase I (Fig. 2). At present, the basic number of this genus cannot be ascertained, for the haploid number with  $n=16$  chromosomes seems to be very high as compared with basic numbers of  $x=9, 11, 12$  and  $13$  (Darlington and Wylie, 1955) of different genera of this family.



FIGS. 1-2. Figs. 1 & 1a. Somatic metaphase showing  $2n=32$  chromosomes and idiogram. Fig. 2. Meiotic metaphase I, showing 16 bivalents.

Thanks are due to Dr. R. P. Patil for going through the manuscript.

Central Botanical Lab., NITYANANDA DATTA.  
76, Lower Circular Road,  
Calcutta-14, April 18, 1968.

1. Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, London, 1955.

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## REVIEWS AND NOTICES OF BOOKS

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**Layered Igneous Rocks.** By L. R. Wager and G. M. Brown. (Oliver and Boyd, Edinburgh and London), 1968. Pp. xv + 588. Price £ 8-8 sh.

Among the igneous rocks of the Earth, those exhibiting the distinctive feature called layering are of special significance to petrologists, mineralogists and geochemists, for they provide a remarkably detailed record of the crystallisation and differentiation of magmas—a primary geological process. This book, written by two of the world's leading authorities on the subject, is the first to be published on these important igneous rocks. In Part I the authors present a detailed analysis of the crystallisation history of the classic Skaergaard intrusion, using all the evidence obtained since it was first discovered by the senior author in 1930. In Part II the results of work by them and others on a wide variety of basic, ultrabasic, syenitic, and granitic layered intrusions are presented and discussed in the light of modern petrological thought. The main emphasis throughout the book is on features resulting from high-temperature sedimentation, and on the mineralogical and chemical changes associated with crystal fractionation, in slowly cooled natural magmas.

C. V. R.

**Production and Mineral Cycling in Terrestrial Vegetation.** By L. E. Rodin and N. I. Bazilevich. (Oliver and Boyd Ltd., Publishers, Tweeddale Court, 14 High Street, Edinburgh 1), 1967. Pp. 288. Price £ 7-7 sh.

This translation of a Russian book first published in 1965 gives material not hitherto available in English. This book, besides giving a comprehensive review of present information about the productivity and mineral cycling in the main types of the world's vegetation, presents extensive data otherwise only available in publications in Russian.

Only recently attempts have been made to assess the actual yields of different types of vegetation, particularly important in view of the needs for increased food production and better use of land which are among the main objects of the International Biological Programme. A variety of chemical elements, each

undergoing a cycle of uptake and release, is involved in the production of plant material. Studies of the ways in which these different cycles intermesh and control the yield provide a key to an understanding of what it is that determines the character of vegetation in a particular place. The information here presented will assist in the more effective use of forest, pasture and wilderness.

The contents of this volume are: Introduction; Tundra and Forest-Tundra; Coniferous and Mixed Forests; Deciduous and Broad-Leaved Forests; Steppeland; Deserts and Other Desert Zone Coenoses; Tropical and Subtropical Forests and Savanna; and Types of Biological Cycle of Ash Elements.

The book will be found to be of interest by Agriculturists, Foresters and Geographers as well as Plant Ecologists, Conservationists and Geochemists.

C. V. R.

**Theory and Applications of Holography.** By Develis-Reynolds. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place London, W. 1, England), 1967. Pp. xii + 196. Price \$ 12.95.

The book gives a historical introduction and heuristic description of various holographic systems. This coverage, along with the discussion of applications, may be read as a separate unit. The mathematical analysis of the general hologram process as an imaging device, including a discussion of its limitations, is also separately treated. The description utilizes the classical theory of partial coherence to emphasize the general nature of the hologram process, and present-day applications, e.g., holographic microscopy, data storage and processing, optical computing, etc., are considered.

The articles contained in this book are: Introduction; Types of Holograms and a Physical Description of Hologram Processes; Mathematical Analysis of Hologram Processes; Magnification Considerations for Hologram Systems Utilizing Quasi-monochromatic Coherent Radiation; Film Effects and Resolution Limitations for Holographic Systems Utilizing Quasi-monochromatic Coherent Radiation; Holography and Quasi-monochro-

matic Incoherent Radiation; Analysis of Hologram Formation by Quasi-monochromatic Partially Coherent Radiation; and Applications.

This book will be found useful by persons engaged in holography and related research in industry and by the student at the senior or graduate level.

C. V. R.

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Annual Review of Physiology (Vol. 30).

Edited by Victor E. Hall. (Annual Reviews, Inc., 4139 El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. ix + 773. Price \$9.00.

The publication of this volume of the *Annual Review of Physiology* marks the end of an era, for it will be the last to have been prepared under the general overseeing of Dr. James Murray Luck, who retires this year as Editor-in-Chief of Annual Reviews, Inc. It was he who, after the marked success which attended his founding of the *Annual Review of Biochemistry*, saw the possibility of a companion review in physiology.

The reader may be puzzled by the conspicuous number (1000 to 1016) aligned in the margin with the title of each review in this volume; it is a key for use in the ordering of reprints.

The articles contained in this volume are: Prefatory Chapter: Research Provides Self-Education by E. F. Adolph; Membrane Phenomena; Regulation of Internal Body Temperature; Muscle; Kidney; Respiration; The Gastrointestinal Circulation; Systemic Circulation: Local Control; Hemodynamics; Nervous System: Afferent Mechanisms; Activities of the Central Nervous System: Motor; Distal Mechanisms of Vertebrate Colour Vision; Regulation of the Adenohypophysis; Adrenal Cortex; The Neurohypophysis; The Thyroid; Reproduction; and Osmotic and Ionic Regulation.

C. V. R.

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The Structural Basis of Antibody Specificity.

By David Pressman and Allan L. Grossberg. (W. A. Benjamin, Inc., One Park Avenue, New York 10016), 1968. Pp. xvii + 279. Price \$16.75.

This book is the fifth to appear in a series of monographs on Microbial and Molecular Biology. The purpose of this series is to encourage and sponsor the publication of carefully selected and edited short monographs on

topics in the forefront of research in these fields.

The text treats those structural features of haptens or antigens and of antibodies which provide the basis for their specific interaction. The first two chapters introduce the chemical concepts which are involved in antibody-antigen interaction. Chapter 3 discusses a large number of anti-hapten systems in depth in terms of the structural details important for antibody-hapten combination. The following chapters discuss the basis of the heterogeneity of antibody molecules, and the use of antibodies to map out structures of small and large molecules in aqueous solution.

Liberal use is made of drawings of chemical structures together with their names, so that biology students can easily grasp and follow the discussion of chemical principles involved, and an extensive bibliography and appendix gives access to a large number of studies of anti-hapten systems.

C. V. R.

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A First Course in Calculus (2nd Edition). By Serge Lang. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London W. 1, England), 1968. Pp. xiv + 314. Price \$41.00.

The purpose of this book is to teach the student the basic notions of derivative and integral, and the basic techniques and applications which accompany them. In this Second Edition, a chapter on complex numbers is included and the exercise sets have been greatly expanded.

The contents of this volume are: Numbers and Functions; Graphs and Curves; The Derivative; Sine and Cosine; The Mean Value Theorem; Sketching Curves; Inverse Functions; Exponents and Logarithms; Integration; Properties of the Integral; Techniques of Integration; Some Substantial Exercises; Applications of Integration; Taylor's Formula; Series; and Complex Numbers.

C. V. R.

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Internal Friction in Metals and Alloys. Edited by V. S. Postnikov, F. N. Tavazde and L. K. Gordienko. (Consultants Bureau, New York), 1967. Pp. 266.

In this publication are collected together nearly 50 papers embodying the results of recent Soviet research on Internal Friction (I.F.). Many of the papers were discussed at the 1964 Tbilisi Conference on Internal Friction. The papers are grouped under the

following broad heads: Internal Friction in Pure Metals and Alloys; I.F. in Steels; I.F. in Constructional Materials at High Vibration Amplitudes; Instruments and Methods for measuring I.F.; and I.F. Theory. A. S. G.

**Marine Fisheries in India.** By C. T. Samuel. (Oceanographic Laboratory, University of Kerala, Cochin-16). Pp. 254. Price: Indian Edition Rs. 20-00; Foreign Edition \$7.00.

This compilation presents in a compact book form important available information on marine fisheries in India. The book contains many tables and charts giving statistical data on different fishes of economic importance, their catches, export, etc. A useful book for students and research workers in marine fishes. A. S. G.

**Bibliography of Marine Fisheries and Oceanography of the Indian Ocean: 1962-1967.** (Bulletin No. 1 of the Central Marine Research Institute, Mandapam Camp, Ramana-thapuram Dt., Madras State).

This Bibliography in mimeographed print lists about 2,800 papers relating to Indian Ocean and its Fisheries that have been published between 1962 and 1967. About 50% of the cited literature refer to papers published in India. The present publication may serve as a useful companion volume to the "Partial Bibliography of the Indian Ocean" issued by the U.S. Programme in Biology during the International Indian Ocean Expedition of 1962-1965. A. S. G.

#### Books Received

**Internal Friction in Metals and Alloys.** Edited by V. S. Postnikov, F. N. Tavazde and L. K. Gordenko. (Plenum Publishing Corp., New York, 10011), 1967. Pp. x + 266. Price not given.

**Biologisches Zentralblatt.** By Hans Stubbe. (VEB George Thieme Leipzig, Absatzabteilung, 69, Jena, Villengang 2), Pp. 552. Price 116 MDN.

**Linear Algebra and Its Applications** (Vol. I, No. 1). (American Elsevier, Publishing Co., Inc., 52, Vanderbilt, Avenue, New York, N.Y. 10017), January 1968. Pp. 152. Price \$24.00 per year.

**Annual Review of Physiology** (Vol. 30). By V. E. Hall, A. C. Giese and R. R. Sonnen-schein. (Annual Review, Inc., 4139 El Camino-way Palo Alto, California, U.S.A.), 1968. Pp. ix + 773. Price: USA \$8.50; elsewhere \$9.00.

**Aspects of Yeast Metabolism.** Edited by A. K. Mills and Sir Hans Krebs. (Blackwell Scientific Publications, 5, Alfred Street, Oxford, England), 1967. Pp. xiv + 345. Price 77 sh. 6d.

**Spectroscopic Tricks.** Edited by Leopold May. (Adam Hilger Ltd., 98, St. Pancras Way, London N.W. 1), 1968. Pp. xiv + 333. Price 84 sh.

**Research Methods in Plant Ecology.** By S. C. Pandeya, G. S. Puri and J. S. Singh. (Asia Publishing House, Ballard Estate, Bombay-1), 1968. Pp. x + 272. Price Rs. 30-00.

**Transistor Physics and Circuits** (2nd Edition). By M. P. Ristenbatt and R. L. Riddle. (Asia Publishing House, Bombay-1), 1968. Pp. xviii + 547.

**The Ecology of Soil Bacteria.** Edited by T. R. G. Gray and D. Parkinson. (Liverpool University Press, 123, Grove Street, Liverpool-7), 1968. Pp. xv + 681. Price 150 sh.

**Final Report of the Special Coffee Research Association.** By V. Agnihothrudu. (Rallis India Ltd., F. and P. Division, 6 A, Cunningham Road, Bangalore-1), 1968. Pp. 107.

**Physics Experiments and Projects.** By W. Bolton: 1. Properties of Materials, Pp. xvi + 87; 2. Waves and Particles, Pp. xvi + 97; 3. Atomic Physics, Pp. xiv + 109; 4. Electricity, Pp. xv + 130. (Pergamon Press Ltd., Headington Hill Hall, Oxford), 1968. Price: 8 sh. 6d. each.

**The Theory of Absolute** (1st Edition). By Surendra. (Published by the Author, Department of Applied Geology, Indian School of Mines, Dhanbad), 1968. Pp. 123. Price Rs. 3-00.

**Space Time and Relativity.** By R. Nevenlinna. (Addison-Wesley Pub. Co., Inc., 11, Hills Place, London W.1, England), 1968. Pp. xii + 158. Price 28 sh.

**Problems for Introductory University Chemistry with Complete Solutions.** By J. N. Butler, B. A. Dunall, L. G. Harrison. (Addison-Wesley Pub. Co., Inc., 11, Hills Place, London W.1, England), 1967. Pp. vii + 213. Price 22 sh.

# MANGANESE IN THE SHELF SEDIMENTS OFF THE WEST COAST OF INDIA

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AS a part of the programme aimed at understanding the nature and distribution of different elements in the marine sediments fringing the west coast of India in relation to their source and environmental factors, the distribution pattern of manganese has been determined and the results of the same are presented in this short note. The locations of the stations from where the sediment samples were collected are given in Fig. 1.

shelf and slope regions. This is particularly so between Alleppey and Karwar while off the Bombay coast, the shelf, for the greater part, is covered by fine-grained sediments.

Manganese has been determined in these sediments colorimetrically using the method described by Sandell.<sup>1</sup> All the measurements were made on 'UNICAM' spectrophotometer SP 500 at 545 m $\mu$ . Although manganese has been estimated in the sediments by the authors on the total sample (including sand fraction) as well as in the silt and clay fraction, for the purpose of this paper, the values obtained in the silt and clay fraction alone are presented in Figs. 2-6 (not on carbonate free basis) and it may suffice to add here that the values obtained on the total sample basis are generally found to be less than those obtained in the finer fraction.

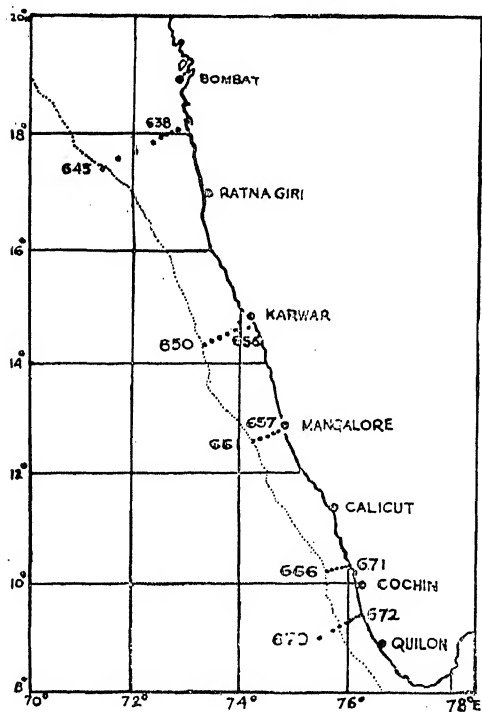
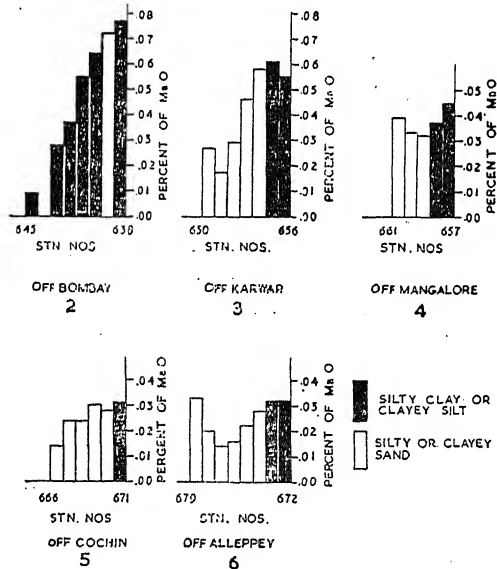


FIG. 1 Map showing the station locations.

In the area under study, the sediments exhibit a well-marked zonation in regard to their distribution in that the inner shelf (upto a depth of about 20 fthm.) is covered by silty clays or clayey silts and this is followed by a zone of silty or clayey sands in the rest of the



FIGS. 2-6. Manganese concentration and texture of the sediments.

An examination of data presented in

Figs. 2-6 reveals the following distribution pattern for the manganese in these sediments:

(i) There is a progressive increase in the manganese content of the sediments from south to north.

(ii) Along any given section, there is a progressive decrease in the manganese content in a direction seaward and away from the coast and

(iii) Along all the sections except off the Bombay coast, the sediments in the slope region are slightly more enriched in their manganese content than the immediately adjoining sediments in the shelf region.

The manganese content of the deep sea deposits has been attributed to different agencies: volcanic eruption, submarine weathering, chemical precipitation, biological extraction, etc. But in the case of the shelf deposits forming not far away from the land, the source must be found in the adjacent land mass itself. Manganese is carried to the sea both in solution and as a constituent of sedimentary debris (Murata, 1939).<sup>2</sup>

During weathering manganese is dissolved mainly as bicarbonate. Divalent manganese is readily oxidised to quadrivalent state when the waters bearing the manganese come into contact with the atmospheric or dissolved oxygen in the lake waters or the shallow near-shore waters. pH is another important factor controlling the migration of manganese and the colloidal hydroxides of manganese precipitate at pH 6. According to Rankama and Sahama<sup>3</sup> this precipitation takes place mostly in the river waters itself, while some manganese is precipitated in the brackish water areas. Thus what little manganese that is supplied to the sea will be preserved in the sediments as long as they are in contact with oxygenated waters.

The progressive decrease in the manganese content of the sediments in the seaward direction shows that the contribution is practically from land. A consideration of the distribution pattern of the sediments (particularly between Alleppey and Karwar) shows that the inner shelf is characterised by high rates of sedimentation. The sediments in the outer shelf have been described as relict sediments by Nair *et al.*<sup>4</sup> which are characterised by a high content of carbonate. The favourable hydrographic conditions for the deposition of fine-grained sediments in the inner shelf and the adsorption of manganese by these colloidal particles may account for the relatively high manganese observed in the inshore sediments along all

the sections. While this is so in any given section, the manganese distribution shows a definite trend in the north-south direction also in that it decreases progressively from north to south. The climatic conditions on land and the hydrographic conditions in the shelf region being similar along the different parts of the west coast of India, the decreasing trend towards the south may have to be attributed to the differences in the rock types present along the different parts of the west coast of India (Deccan traps along the Bombay coast, Granitic rocks along the Mysore coast and the Tertiary and Sub-Recent formations, Peninsular gneissic complex and the Charnockitic rocks along the Kerala coast). The low values of manganese observed in the sediments of the 'Vembanad Lake' in Kerala State and the associated rivers by one of the authors (Murty, unpublished) confirms this surmise.

The sediments in the slope region are slightly enriched in their manganese content than the immediately adjoining sediments in the shelf region, along all the sections except off Bombay. Murty *et al.*<sup>5</sup> have reported high organic matter content in the slope sediments of the area under study and attributed the same to its preservation under a reducing environment. While the low manganese content off the Bombay coast is understandable in view of the fact that part of the manganese precipitated may be redissolved at the bottom under reducing conditions, it is difficult to explain enrichment in the slope sediments of other regions, particularly in view of their similarity in texture as well as composition to the immediately adjoining shelf sediments (silty or clayey sands characterised by high carbonate content). The only possible reason which can be offered is that these slope sediments are characterised by a high content of foraminiferal tests and perhaps manganese has been extracted from the waters by the planktonic foraminifera and preserved in their tests. The possibility of biological extraction of manganese from solution in sea-water involving the ingestion of this element by planktonic foraminifera and retention in their shells has been suggested by Correns<sup>6</sup> and confirmed by Goldberg *et al.*<sup>7</sup> as a mechanism contributing to the process of bringing manganese to the sediments.

#### ACKNOWLEDGEMENT

The authors wish to thank Dr. N. K. Panikkar, Director, National Institute of Oceanography,



CSIR, for his keen interest and encouragement in the present investigations and Shri R. Jayaraman, National Institute of Oceanography, CSIR, for his helpful suggestions in the preparation of this paper.

1. Sandell, E. B., *Colorimetric Determination of Traces of Metals*, Interscience, New York, 1950.
2. Murati, K. J. *Amer. Jour. Sci.*, 1939, 237.

3. Rankama, K. and Sahama, Th. G., *Geochemistry*, The University of Chicago Press, Chicago, 1950.
4. Nair, R. R. and Abraham Pylee, *Abstracts of Papers, NISI/INCOR Symposium on Indian Ocean*, March 2-4, 1967.
5. Murty, P. S. N., Reddy, C. V. G. and Varadachari, V. V. R., *Proc. Nat. Inst. Sci. India* (In press).
6. Correns, C. W., *Nachr. Akad. Wiss. Gottingen, Math. Phys.*, Kl., 1941, 5.
7. Goldberg, E. D. and Arrhenius, G. O. S., *Geochim. et Cosmoch. Acta*, 1958, 13.

## INFLUENCE OF HEAT ON SOIL STRUCTURE

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IT has been known from time immemorial in India that heating a soil, either by lightly burning it or by burning stubble on it, will increase the yield of the following crop.<sup>1</sup> A similar practice in areas having intense dry season is to leave the bare soil exposed to the sun, so it gets baked out. This is again practised in India and in Egypt.<sup>1</sup> However, the scientific basis for this age-old practice is not fully understood.

### EARLY EXPERIMENTS

In 1888 Frankc<sup>2</sup> gave some experimental evidence on the effect of heat on soil: he obtained larger crops of oats and of yellow lupines on heated than on unheated soil; and he showed also that heating increased the solubility of the mineral and of the organic matter in the soil. Five years later Liebscher<sup>2</sup> stated that the sterilisation of soil by steam increased the availability of the phosphates and nitrogen compounds.

Russell and his co-workers,<sup>2-5</sup> who investigated the influence of partial sterilisation of soil on the production of plant food in the early years of this century, reported that when a soil had been heated to 95° C. it produced two, three, or sometimes four times as much crop (e.g., spinach, tomato, turnips, lettuce and tobacco plant) as a portion of the soil which had not been heated.<sup>3</sup> They obtained such results not only with fertile soils but with an exhausted Rothamsted soil.<sup>3</sup> They stated that the heat treatment had in some way brought about a considerable increase in the amount of nitrogen, phosphorus, and potassium obtainable by the plant.<sup>3</sup>

### EXPERIMENTS WITH "SICK" SOILS

Russell and Petherbridge studied the effect of temperature and of antiseptics, such as toluene and carbon disulphide, on "sick" soils from glass-house (sick soils occur in different parts of the world, e.g., beet sickness on the Continent,<sup>4</sup> the flax and corn-sick soils of Dakota,<sup>4</sup> U.S.A.: sewage-sick soils at Kegworth,<sup>6</sup> U.K., Baroda<sup>7</sup> and Bangalore,<sup>8</sup> India) and reported that "exposure to a temperature of 96°-98° C. for two hours has proved the most effective because it not only kills destructive and parasitic organisms, including *Heterodera*, but also effects a certain amount of decomposition, thus lightening the subsequent work of bacteria and bringing about certain secondary results, notably a great development of fibrous root".<sup>4</sup> Russell and Golding,<sup>6,9</sup> who studied sewage-sickness in soil and its amelioration by partial sterilisation, also reported that heating the soil or treating it with antiseptics was effective. Russell and his co-workers believed that the sickness in glass-house soils and sewage-sickness in soil are, in part, due to an abnormal development of a factor always present in ordinary soils and detrimental to bacteria.<sup>6</sup> This harmful factor, which was identified as the protozoa such as *Colpoda cucullus*,<sup>3</sup> *amoebæ*,<sup>9</sup> *Euglena*<sup>9</sup> and *Vorticella putrina*,<sup>9</sup> was put out of action by heat or by antiseptics. The soils thus treated produced more crops.

For over three decades the effect of sewage as a manure as well as irrigation water on soil conditions and plant growth has been under continuous study in this Department. The

experimental observations relevant here include<sup>10-13</sup>: (1) Surface heating of "sewage-sick" soil brought about an increase of about 300% in the yield of French beans (*Phaseolus vulgaris*) over the unheated control soil. (2) Other treatments of the "sewage-sick" soil, e.g., heating *en masse*, application of burn, lime at the rate of 10 g. per 30 lb. of the soil and resting it for 3 weeks, and changing the surface layers or bottom layers of the soil, also gave increased yields ranging from 100 to 200%. (3) While these strikingly increased yields were obtained on replacing sewage irrigation with ordinary water following the treatments, continued use of sewage after any of the above treatments gave only an increase of 20 to 25%. (4) Experiments with different soils, with sewage diluted with water in different proportions, application of sewage and water at different stages of plant growth, with sewage effluents purified to varying extent, and related experiments showed clearly that the pore space in the soil and the presence of a certain amount of dissolved oxygen in the diluted sewage or treated sewage (raw sewage contains little or no dissolved oxygen) had a decisive influence on the availability of nitrogen and phosphorus in the soil and its productivity. (5) Further experiments and the field trials emphasized the primary importance of adequate air supply to the soil under sewage for the maintenance of its health and productivity.

#### SOIL STRUCTURE AND AERATION

Hall *et al.*<sup>14</sup> demonstrated the remarkable influence of continuous aeration of nutrient solutions on the development of the root system and its close bearing on the superiority of the cultures in coarse sand and kaolin over the ordinary water cultures in which the aeration was not continuous. Howard and Howard,<sup>15</sup> and Howard<sup>16</sup> who made a study of soil "ventilation" or aeration and productivity of soils at Pusa, Lyallpur, Quetta, and in Central India reported that: "In many cases, results have been noticed which are most easily explained by the want of an adequate supply of air in the soil".<sup>15</sup> They also reported that: "Water, when it excludes air from the roots, acts as if it were a poison to crops".<sup>15</sup>

Aeration in soil is closely related to its structure which is essentially the arrangement of soil particles. The percentage of water-stable aggregates of different sizes generally

give a measure of the extent of soil aeration in the soil. While it is generally recognized that the primary strength of soil aggregates is given by clay particles, the exact nature of the clay mineral composition of the soil is not known.

Rao and Ramaswami<sup>17</sup> used a water balance in heated soil during, through, and over the soil. Dehri and reported that the rate of soil temperature is mainly to stabilize the aggregates already present in the natural soil, and that it is promoting a slightly higher water stability, that thus, the duration of soil aggregates with respect to water steadily increases with increasing temperature of heating up to 60°C, at which point the aggregates become quite water-stable, and that the stability remains unchanged above this temperature. His studies of Gupta and Datta<sup>18</sup> on water stability of aggregates in heated soil, confirm that of Naspur indicated that an extremely low temperature (360°C) for attaining a very high water stability of the soil coincides with the temperature for collapse of the clay "structure", and that "further heating of the soil results in a little increased water stability, though the end result of heating soil to high temperatures (1000°C) is aggregation of the primary particles, but disintegration of the larger aggregates." Salomon *et al.*,<sup>19</sup> in a comparative study of autoclaved and gamma-irradiated soil as media for microbial colonization experiments, found that the aggregate stability of Lincoln Clay was decreased (to 6.48%) by irradiation and increased (to 11.62%) by autoclaving (121°C for 3 hr). Their measurement of the soil aggregates was limited to the size 0.025 mm. Datta<sup>20</sup> has suggested that only those aggregates that are larger than 0.25 mm are responsible for stable soil structure.

Recently, in the course of a study of the effect of different forms of organic matter and inorganic fertilizers on the formation of soil aggregates, we have made some interesting observations on the influence of heat on soil structure. These observations are briefly described here.

#### INFLUENCE OF HEAT ON SOIL AGGREGATES OF DIFFERENT SIZES

*Influence of heat on the aggregates in soils containing different forms of organic matter.* Samples of Bangalore red loam soil (200 g) were mixed separately with defatted ground nut cake (2.23 g.), cow dung (12.00 g.), straw

powder (27.60 g.), leaf powder (27.60 g.), and a mixture of ammonium sulphate (0.933 g.) and superphosphate (0.267 g.). All these materials were added on an equal nitrogen basis. 800 ml. distilled water was added to each of them in a series of glass jars (2-litre capacity) kept on the laboratory bench. A control was maintained with the soil (200 g.) and distilled water (800 ml.) in one glass jar. It was considered that this soil-water proportion might facilitate the changes in the different systems. On the sixth day, the supernatant liquids were decanted and the sediment in each case was divided into two portions. One portion was dried on a water-bath for 12 hours and later in an oven (103°C.) for 3 days and the other portion was kept in the jar itself.

Both the heated and the unheated samples were kept under 1:5 water for 24 hours and were then sieved by the method of Tiulin,<sup>23</sup> which was modified as follows: In a bucket of water, a series of sieves (2 mm., 1 mm., 0.5 mm. and 0.25 mm. in the order from the top) were kept in a vertical row and the soil sample was placed on the top sieve. The sieves were moved up and down in water ten times, each time allowing the water to leave from the sides of the sieves. The sieves were then taken out and the material remaining on each sieve was washed into an evaporating dish. The excess water was decanted and filtered through filter-paper. The filter-paper, together with the soil, was dried in an oven (103°C.) and weighed. The percentages of water-stable aggregates were calculated and are given in Table I. The total percentages

increase in the total percentages of soil aggregated; (2) that heating in every case considerably increased 0.25 mm. size aggregates; (3) that in the control soil and in the soils treated with groundnut cake and cow dung the percentages of 1 mm. and 0.5 mm. size aggregates increased as a result of heating, the

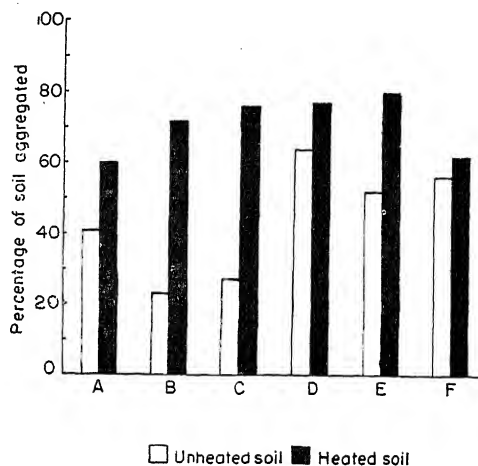


FIG. 1. Influence of heat on the total percentage of aggregation of soils treated with organic materials and inorganic fertilisers. A. Control; B. Groundnut cake; C. Cow dung; D. Leaf powder; E. Straw powder; F. Ammonium sulphate + superphosphate.

increase in 0.5 mm. aggregate with cow dung and the increase in 1 mm. aggregate with groundnut cake were marked; and (4) that only in soils treated with leaf and straw powder there was an increase in 2 mm. aggregates.

TABLE I

*Influence of heat on the percentage distribution of water-stable soil aggregates formed under different treatments*

Treatment	2 mm.		1 mm.		0.5 mm.		0.25 mm.	
	Unheated	Heated	Unheated	Heated	Unheated	Heated	Unheated	Heated
Control	..	Nil	7.0	8.5	10.0	15.0	24.0	36.0
Groundnut cake	..	Nil	1.0	11.0	10.0	16.0	12.0	45.0
Cow dung	..	2.5	2.5	7.0	7.5	33.0	14.5	36.0
Leaf powder	..	4.0	32.0	10.0	24.0	18.0	4.0	28.0
Straw powder	..	12.0	16.0	12.0	12.0	28.0	12.0	16.0
Ammonium sulphate + superphosphate	..	Nil	8.0	11.0	24.0	14.5	24.0	36.0

of soil aggregated are given in Fig. 1. The differences in the total percentages of soil aggregated in the heated and unheated series were statistically analysed (Table II).

These results indicate (1) that in all cases, including the control soil, heating caused an

*Influence of heat on the aggregates in soils treated with aqueous extracts of organic matter and solutions of inorganic fertilisers.*—In another series of experiments, these different forms of organic matter and inorganic fertilisers (same amounts as in earlier series)

TABLE II

Analysis of variance of the total percentage of the soil aggregated

Source	d.f.	Sum of squares (SS)	Mean sum of squares (MSS)	F
Heat	1	2213.333	2213.333	13.010*
Manures	5	861.917	172.383	1.013
Errors	5	850.417	170.083	

\* Significant at 5 per cent. level. (Heating improved the total percentages of water-stable aggregates in the soil).

were added to 800 ml. distilled water and were agitated on a mechanical rotary shaker (200 r.p.m.) for 36 hours. The solutions were filtered through cotton wool. The filtrate were added separately to each sample of 200 g. Bangalore red loam soil kept in glass jars. There was a control with 200 g. soil and 800 ml. distilled water. They were all kept for five days on the laboratory bench and on the sixth day the supernatant liquids were removed. The soil was divided in each case into two portions. One portion was dried on a water-bath for 12 hours and later in an oven (103° C.) for 3 days. Both the heated and the unheated samples of soil were then kept in water (1:5) for 24 hours and were later wet sieved as described above. The results of wet sieving and their statistical analysis are given in Tables III and IV. The results in Tables III and IV show (1) that 0.5 mm. and 1 mm. size aggregates increased in all cases; (2) that 0.25 mm. size aggregates also increased

TABLE III

Influence of heat on the percentage distribution of water-stable aggregates formed in soils treated with solutions of different fertilising materials

Treatment	1 mm.		0.5 mm.		0.25 mm.	
	Unheated	Heated	Unheated	Heated	Unheated	Heated
Control	4.0	5.2	10.0	30.0	20.0	35.2
Groundnut cake*	4.0	9.6	7.0	60.8	24.0	12.0
Cow dung	2.0	14.5	4.0	39.0	18.0	22.6
Leaf powder	2.0	16.0	8.0	71.8	19.0	7.0
Straw powder	Nil	12.0	3.0	60.0	21.0	14.0
Ammonium sulphate + superphosphate	Nil	13.2	3.0	51.0	6.0	24.9

\* 2 mm. diameter aggregates were formed only with groundnut cake in the heated soil sample (2.4 per cent).

TABLE IV

Analysis of variance of the total percentage of the soil aggregated

Source	d.f.	Sum of squares (SS)	Mean sum of squares (MSS)	F
Heat	1	9987.870	9987.870	80.034*
Manures	5	782.177	156.435	12.61*
Error	5	60.010	12.002	

\* Significant at 1 per cent level. Heating improved the total percentage of water-stable aggregates in the soil in the control soil and in the soil treated with aqueous extract of cow dung and soil treated with ammonium sulphate and superphosphate. (3) that 2 mm. size aggregates were formed only in the soil treated with groundnut cake. Figure 2 shows that the total percentage water-stable aggregates were strikingly more in the heated soils under different treatments than in the corresponding unheated soils.

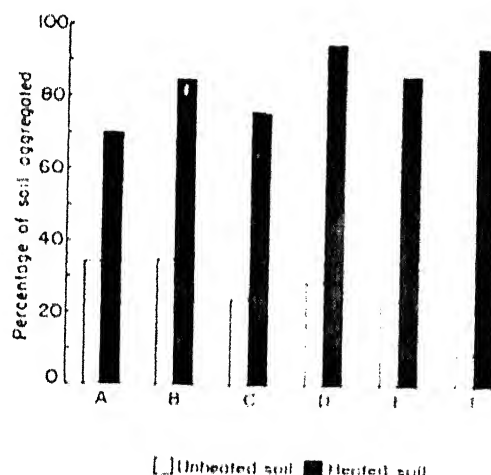


FIG. 2. Influence of heat on the total percentage of aggregation of soils treated with aqueous extracts of solutions of fertilising materials. A, Control; B, Groundnut cake; C, Cow dung; D, Leaf powder; E, Straw powder; F, Ammonium sulphate + superphosphate.

#### SUMMARY

The experimental results described here show that heating the soil, with or without organic matter or inorganic fertilizers, increased to varying extent the total percentage of water-stable aggregates, and the extent of increase depended upon the type of fertilizing material and the manner or mode of its application.

The more interesting observation was on the influence of heat on the aggregate size distribution: aggregates of greater diameter were generally formed, particularly in the soil

samples treated with aqueous extracts or solutions of fertilising materials.

Temperature thus seems to be a physical factor of considerable importance in the formation of suitable aggregates in soil, which facilitate aeration and productivity of the soil. The presence of decomposing organic matter also contributes considerably to soil aggregation. Liming the soil has been known to aid its productivity, presumably by flocculation or aggregation. Among the physical, chemical and biological factors influencing soil structure, temperature is apparently of some special significance to tropical agriculture.

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1. Russell, E. W. and Russell, E. J., *Soil Conditions and Plant Growth*, Longmans, Green & Co., London, 1961, 9th edition, pp. 222, 439.
2. Franks, Leisner, quoted by Parlyshire, F. V. and Russell, E. J., *J. Agric. Sci.*, Camb., 1907, 2, 305, 311, 317.
3. Russell, E. J. and Hutchinson, H. B., *Ibid.*, 1909, 3, 111, 112, 141.
4. — and Petherbridge, F. R., *Ibid.*, 1913, 5, 86, 89, 91, 248.
5. — and Hutchinson, H. B., *Ibid.*, 1913, 5, 152.
6. Russell, E. J. and Golding, J., *J. Agric. Sci.*, Camb., 1912, 5, 27, 47.
7. Pillai, S. C., *Report on the Treatment and Disposal of the Sewage of Baroda*, Submitted to Dr. Fowler, G. J., Technical Representative of Messrs. Activated Sludge Limited, London, for India and the East, 1939.
8. — and Rajagopalan, R., *Investigations on Sewage Farming*, Indian Council of Agricultural Research, New Delhi, 1944.
9. Russell, E. J. and Golding, J., *J. Soc. Chem. Ind.*, 1911, 30, 471, 474.
10. Pillai, S. C., Rajagopalan, R. and Subrahmanyam, V., *Investigations on Sewage Farming*, Indian Council of Agricultural Research, New Delhi, 1945-49.
11. — and —, *Sci. & Cult.*, 1948, 14, 249.
12. —, *Investigations on Sewage Farming*, Indian Council of Agricultural Research, New Delhi, 1955.
13. —, *Indian Farming*, 1961, 11, 24.
14. Hall, A. D., Brechley, W. E. and Underwood, L. M., *J. Agric. Sci.*, Camb., 1914, 6, 278, 298-299.
15. Howard, A. and Howard, G. I. C., *Bulletin No. 52*, Agricultural Research Institute, Pusa, 1915, pp. 3, 35.
16. —, *Bulletin No. 61*, Agricultural Research Institute, Pusa, 1916.
17. Rao, K. S. and Ramachari, P. T., *Soil Sci.*, 1957, 84, 439, 443.
18. Gupta, G. C. and Dutta, A. K., *Ibid.*, 1967, 104, 210, 216.
19. Salenius, P. O., Robinson, J. B. and Chase, F. E., *Plant and Soil*, 1967, 27, 239, 241.
20. Tiulin, A. F., 1928, quoted by Bayer, L. D., *Soil Physics*, John Wiley & Sons, Inc., New York, 1956, 3rd Edition, pp. 173, 177.

## PREPARATION AND PROPERTIES OF BISCYCLOPENTADIENYL TUNGSTEN OXYDICHLORIDE AND BISINDENYL TUNGSTEN OXYDICHLORIDE

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**T**UNGSTEN cyclopentadienyl chlorides,<sup>1</sup> carbonyls<sup>2</sup> and hydrides<sup>3</sup> have already been reported. No work has however been done on the preparation of indenyl derivatives of tungsten, although indenyl derivatives of iron and cobalt,<sup>4</sup> tin,<sup>5</sup> lead,<sup>6</sup> gallium and mercury<sup>7</sup> have been reported by various workers. The present communication deals with a study of preparation and properties of biscyclopentadienyl tungsten oxydichloride (I) and bisindenyl tungsten oxydichloride (II). These compounds have been prepared by direct reaction of tungsten oxytetrachloride with cyclopentadiene as well as with indene in liquid phase using tetrahydrofuran. Compounds (I) and (II) so formed were isolated by removing the solvent under reduced pressure and subsequent recrystallization from THF or diethyl ether. The percentage yield was nearly 80%. Tetrahydrofuran has proved to be a satisfactory medium for carrying out the

reactions of tungsten oxytetrachloride with cyclopentadiene and indene.

#### EXPERIMENTAL

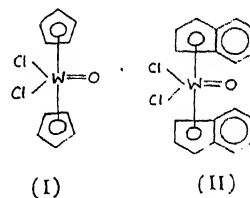
Tungsten oxytetrachloride was prepared by refluxing tungsten trioxide with thionyl chloride and the excess of thionyl chloride was removed by evaporation under reduced pressure. The bright reddish mass so formed was sublimed at 130–35° and yielded scarlet red needles.

*Preparation of Biscyclopentadienyl Tungsten Oxydichloride.*—To 3.5 gm. of tungsten oxytetrachloride (0.1 mole) in 100 ml. of tetrahydrofuran was added 2.7 ml. of cyclopentadiene (0.2 mole) and the mixture was refluxed for 6–7 hours at 75°–80°C. The resultant deep brown solution was freed from solvent by evaporation under reduced pressure and on repeated crystallization from tetrahydrofuran gave light pink crystals (Found: C, 29.9; H, 2.5; W, 45.9; Cl, 17.6%; Calc. for  $(C_5H_5)_2WOCl_2$ : C, 29.92; H, 2.49;

W, 45.88; Cl, 17.60%). These crystals do not melt upto 350° C. and cannot be sublimed under vacuum and are stable in air and soluble in petroleum ether, diethyl ether but sparingly soluble in benzene, toluene and carbon tetrachloride.

**Preparation of Bisindenyl Tungsten Oxydichloride.**—To a cold solution of 3.5 g. tungsten oxytetrachloride (0.1 mole) in 100 ml. of tetrahydrofuran was added 5 ml. of indene (0.2 mole) and the contents were refluxed for 12–14 hr. at 95–100° C. The colour of the solution first changed to light red and then pink and finally brown. The solvent was removed by evaporation under reduced pressure and the solid mass after repeated crystallization from ether gave brown crystals of bisindenyl tungsten oxydichloride [Found: C, 43.05; H, 2.71; W, 36.39; Cl, 14.14%. Calc. for  $(C_9H_7)_2WOCl_2$ : C, 43.11; H, 2.79; W, 36.50; Cl, 14.1%]. These crystals are stable in air for a short period only, melt at 230° C. and sublime at 140–145°/10 mm. These are insoluble in mineral acids and alkalies but soluble in ether, THF and dimethyl formamide. Tungsten was estimated as oxinate and chloride as silver chloride. Infra-red spectra, taken on Perkin Elmer infra cord model 137, is given in Table I.

Infra-red spectra given in Table I indicate that cyclopentadiene and indene react with tungsten oxytetrachloride forming "Sandwich" compounds analogous to other transition metals.<sup>8</sup> On the basis of their analytical data as well as the infra-red spectra, the following structures are suggested for the compounds (I) and (II).



(I)

(II)

TABLE I  
Infra-red spectra of biscyclopentadienyl tungsten oxydichloride and bisindenyl tungsten oxydichloride

Name of compound	C-H stretching	$(C_5H_5)_2$ -metal stretching
$(C_5H_5)_2WOCl_2$ (KBr)	3000 $cm^{-1}$	960, 1110, 1380, 1470, 1640 $cm^{-1}$
$(C_9H_7)_2WOCl_2$ (Nujol)	3010 $cm^{-1}$	$(C_9H_7)$ -metal stretching 1460, 1560, 1600, 1600 $cm^{-1}$

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1. Cotton, F. A. and Wilkinson, G., *Z. Naturforsch.*, 1954, **176**, 417.
2. Wilkinson, W., *J. Amer. Chem. Soc.*, 1954, **76**, 209.
3. Green, M. L., McClavesty, J. A., Pratt, L. and Wilkinson, G., *J. Chem. Soc.*, 1961, **4**, 4854.
4. Pauson, P. L. and Wilkinson, G., *J. Amer. Chem. Soc.*, 1954, **76**, 2024.
5. Zimmer, H. and Sparmann, H. W., *Chem. Ber.*, 1954, **87**, 645.
6. Ans, J. D., Zimmer, H. and Brachwitz, M. V., *Ibid.*, 1955, **88**, 1507.
7. Lesbre, M., Mazerolles, P. and Manel, G., *Compt. Rend.*, 1962, **255**, 544.
8. Wilkinson, G., Cotton, F. A. and Birmingham, J. M., *J. Inorg. Nucl. Chem.*, 1956, **2**, 95.

### ANTIGENIC VARIATION IN *VIBRIO CHOLERA* RESULTING FROM CHROMOSOMAL TRANSFER BY CONJUGATION\*

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THE identification of a fertility system in *Vibrio cholerae* permitted the isolation of genetic recombinants of marked parental strains.<sup>1</sup> Crosses between strains yielded a larger number of recombinants if parental strains were fixed on membrane filters prior to plating on selective media.<sup>2</sup> This technique obviously facilitated cell pairing and effective contact, likely to be less efficient in fluid media because of the active motility of the organism. By this technique it was shown that  $P^+$  strains (possessing the fertility factor

$P$ ) functioned as gene-donors while  $P^-$  strains (devoid of the fertility factor  $P$ ) served as gene-recipients.

Earlier studies with mutants of *V. cholerae*, strain 162, suggested a chromosomal sequence of seven genetic factors as given below:

str ... pur ilva ... O ... arg ... leu ... his. As O (symbolising the genetic determinants of O antigen synthesis) was located between ilva and arg, it was expected that when these are used as selective markers a proportion of the recombinants should inherit the contiguous O antigenic determinants as well. Evidence of this is presented here in which Smooth streptomycin-sensitive  $P^+$  (donor) strains

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were mated with a Rough streptomycin-resistant P<sup>-</sup> (recipient) strain on membrane filters for 60 min. and then plated on selective media for the isolation of recombinants. Results are recorded in Table I.

lised by O. Further studies with Rough mutants (derived from Inaba types) will confirm whether genetic determinants of group and type specificity of Smooth strains are separable by recombination.

TABLE I  
Crosses between Smooth (P<sup>+</sup>) and Rough (P<sup>-</sup>) strains of *Vibrio cholerae*

S. No.	Cross	Selective marker		No. of recombinants tested	No. Rough	No. Smooth
		P <sup>+</sup>	P <sup>-</sup>			
1	A × C	ilva <sup>+</sup>	str-r	50	38	11 (Inaba) 1 (Ogawa)
		arg <sup>+</sup>	str-r	75	69	6 (Inaba)
		his <sup>+</sup>	str-r	37	37	Nil
2	B × C	ilva <sup>+</sup>	str-r	60	50	10 (Ogawa)
		arg <sup>+</sup>	str-r	65	62	3 (Ogawa)

Key = str-s = streptomycin-sensitive  
str-r = streptomycin-resistant  
O-In = O antigenic type Inaba  
O-Og = O antigenic type Ogawa  
O-R = Rough

\* Mutants of *V. cholerae*, Ogawa 162/p.

arg = arginine  
ilva = isoleucine + valine  
his = histidine  
+ = independence  
- = dependence

It will be seen that a significant number of Smooth strains could be identified among the recombinants resulting from the two crosses performed. The O antigenic type of these strains, with one exception, corresponded to that of the donor strain. The unselected markers were invariably those of the recipient, confirming that segmental transfer from P<sup>+</sup> to P<sup>-</sup> cells was restricted to one or two adjacent loci. If selection was made for his<sup>+</sup> marker of the donor strain (cross 1), all the recombinants tested were Rough indicating absence of linkage between his and O.

As Rough strains of *V. cholerae* are often isolated from Cholera convalescents, and as such strains are known to be avirulent, the present study suggests their possible reversion to Smooth virulent types by conjugation with appropriate fertile strains. This is of interest because of the well-known stability of Rough strains of *V. cholerae* in contrast to type variation (Ogawa to Inaba) observed in Smooth strains.<sup>3,4</sup> The solitary isolation of a recombinant, with an antigenic type different from that of the donor strain, may be due to the persistence of genetic determinants of type-specificity (as distinct from group specificity) in the Rough strain, which is perhaps expressed only when associated with group specific genetic determinants, rendered possible in this case by a cross-over within the region symbo-

In this study, efforts were made only to identify and type Smooth strains among the recombinants isolated. This was rendered easy because Smooth strains are not agglutinated by Rough 'O' serum, whereas Rough and partially Rough (Smooth-Rough) strains are invariably agglutinated by this serum. It is possible that some of the recombinants may have been of the intermediate variety, resulting from cross-overs in the region O.

The scope of this study may be profitably enlarged by using non-cholera vibrio strains as donors in such crosses, which, if successful, would result in Rough (as well as Smooth) recipient strains of *V. cholerae* developing O antigens serologically different from O group 1<sup>5</sup> which characterise *V. cholerae* (and *V. El Tor*). This will be of considerable interest particularly with reference to cholera genicity of these hybrids. Such studies are in progress.

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1. Bhaskaran, K., *Bull. Wld. Hlth. Org.*, 1964, **30**, 845.
2. —, Sinha, V. B. and Iyer, S. S., *Curr. Sci.*, 1967, **36**, 257.
3. Shrivastava, D. L. and White, P. B., *Indian J. med. Res.*, 1947, **35**, 117.
4. Bhaskaran, K. and Gorrill, R. H., *J. gen. Microbiol.*, 1957, **16**, 721.
5. Gardner, A. D. and Venkataraman, K. V., *J. Hyg. Camb.*, 1935, **35**, 262.

## LETTERS TO THE EDITOR

ON COUPLED WAVE EQUATIONS FOR  
STRATIFIED GYROTROPIC  
WARM PLASMAS

In this note, some equations given by Talekar and Rawat<sup>1</sup> are extended to allow for stratification of the medium.

Coupled wave equations for propagation in generally inhomogeneous gyrotropic warm plasmas have been derived by Burman.<sup>2</sup> Here, a special case is dealt with. The same notation is used; in particular  $M$  and  $\epsilon$  are the susceptibility and relative permittivity tensors, defined as for cold plasmas. The plasma is taken to be horizontally stratified and horizontally magnetized. Rectangular cartesian co-ordinates  $(x, y, z)$  are used with the properties of the medium depending on the vertical or  $z$  co-ordinate only, and with the magnetostatic field in the  $y$  direction. Hence

$$\epsilon^{-1} = \begin{pmatrix} M & 0 & iK \\ 0 & \epsilon_0/\epsilon'' & 0 \\ -iK & 0 & M \end{pmatrix} \quad (1)$$

with the elements<sup>3</sup> functions of  $z$  only. ( $M$  is not to be confused with the dyadic  $M$ ). Propagation transverse to the magnetostatic field will be considered.

A horizontally polarized electromagnetic wave (one in which the electric field has a  $y$  component only) will propagate as in a cold non-magnetized plasma. But a vertically polarized electromagnetic wave, in which  $H$  has a  $y$  component  $H_y$  only, is coupled to an electro-acoustic wave. For such waves, suppose that equations (10) and (12) of ref. 2 have solutions of the form  $H = \bar{H}(z) \exp(-ik_0 Sx)$  and  $p = \bar{p}(z) \exp(-ik_0 Sx)$  where  $S$  is a constant, and let a dash denote differentiation with respect to  $z$ . It follows after some calculations that

$$(1 - \chi_1 \chi_2) \bar{H}'' + (P_1 - \chi_1 \psi_2) \bar{H}' + (Q_1 - \chi_1 \phi_2) \bar{H} = \frac{e}{\omega m} [(\phi_1 - \chi_1 Q_2) \bar{p}' + (\psi_1 - \chi_1 P_2) \bar{p}'] \quad (2)$$

and

$$(1 - \chi_1 \chi_2) \bar{p}'' + (P_2 - \chi_2 \psi_1) \bar{p}' + (Q_2 - \chi_2 \phi_1) \bar{p} = \frac{\omega m}{e} [(\phi_2 - \chi_2 Q_1) \bar{H}' + (\psi_2 - \chi_2 P_1) \bar{H}] \quad (3)$$

where

$$P_1 = \frac{M'}{M}, \quad Q_1 = k_0^2 \left( \frac{1}{M} - S^2 \right), \quad k_0 S \frac{K'}{M},$$

$$\phi_1 = \frac{k_0 S}{M} \left\{ \left( 1 - \frac{M'}{X} \right)' - k_0 S \frac{K}{X} \right\},$$

$$\psi_1 = \frac{1}{M} \left( \frac{K}{X} \right)', \quad \chi_1 = \frac{K}{XM}, \quad (4)$$

and

$$P_2 = \frac{X^2}{M} - 1 \left( \frac{M}{X^2} - 1 \right)',$$

$$Q_2 = \frac{\omega^2}{u_0^2} \frac{X}{M} - 1 \left( k_0^2 S^2 - k_0 S \frac{X^2}{M} - 1 \left( \frac{K}{X^2} \right)' \right),$$

$$\phi_2 = k_0 S \frac{X}{M} - 1 \left\{ X \left( 1 - \frac{M'}{X} \right)' - k_0 S K \right\},$$

$$\psi_2 = \frac{X^2}{M} - 1 \left( \frac{K}{X} \right)', \quad \chi_2 = \frac{XK}{M} - 1. \quad (5)$$

When the medium is homogeneous, using the definitions<sup>3</sup> of  $M$  and  $K$  it can be shown that (2) and (3) reduce to

$$H'' + k_0^2 \left( 1 - \frac{X}{U} - S^2 \right) H = \frac{e}{\omega m u_0^2} \frac{Y}{U} \bar{p} \quad (6)$$

and

$$\bar{p}'' + \left[ \frac{\omega^2}{u_0^2} \frac{U}{e} \left( 1 - \frac{X}{U} - \frac{Y^2}{U^2} \right) - k_0^2 S^2 \right] \bar{p} = \frac{\omega m}{e} \frac{k_0^2 XY}{U} H, \quad (7)$$

which are equivalent to the equations derived by Talekar and Rawat.<sup>1</sup> [Note that in their work  $e$  is positive, whereas here it is negative. Also, there appears to be a factor  $e$  missing in the third term of equation (11) of ref. (1).]

When the magnetostatic field vanishes,  $K = 0$  and  $M = 1/\epsilon$ , where  $\epsilon = 1 - X/U$  is the scalar relative permittivity defined as for a cold isotropic plasma. Then (2) and (3) reduce to equations obtained previously.<sup>4</sup>

Department of Physics, R. BURMAN.  
Univ. of Western Australia,  
June 26, 1968.

1. Talekar, V. L. and Rawat, S. S., *Curr. Sci.*, 1968, **37**, 222.
2. Burman, R., *Proc. IEEE*, 1967, **55**, 723.
3. Wait, J. R., *Electromagnetic Waves in Stratified Media*, Pergamon Press, Oxford, 1962, Chapter 8.
4. Burman, R., *Proc. Camb. Phil. Soc.*, 1967, **63**, 1229.



# CRYSTAL STRUCTURE DETERMINATION OF 5-BROMO VERATRIC ACID

EXTREMELY thin hair-like crystals of 5-bromo veratric acid (3-4-dimethoxy 5-bromo benzoic acid) were obtained from a solution of the substance in alcohol.

Diffraction data in the only orientation possible for the crystal were collected using Cu K $\alpha$  radiation.

The axis of rotation is *a*. The following crystallographic data were obtained:

$$a = 4.07 \text{ \AA}, \quad b = 16.06 \text{ \AA}, \quad c = 15.30 \text{ \AA} \\ \beta = 93^\circ 6'$$

Space group P2 $_1$ /c

No. of molecules per unit cell = 4.

The *okl* intensity data obtained by Weissenberg photographs using the multiple films method, were corrected for Lp; a (100) Patterson projection was made (Fig. 1).

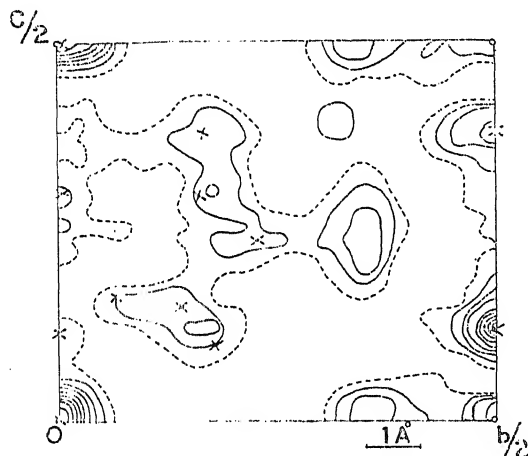


FIG. 1. (100) Patterson projection.

As Br-C interaction is predominantly heavier than the interaction between light atoms, the (100) Patterson was expected to show the molecule without difficulty. The ring and the connected atoms were easily identified in the Patterson map.

The fractional co-ordinates of bromine itself were found to be 0.25, 0.192.

Bromine in this position makes no contribution to the intensity of the odd-odd and even-odd reflections in *okl*.

The orientation of the ring is such that the ten light atoms C $_1$  to C $_8$ , and O $_1$  and O $_2$  nearly cancel each other, making possible only a negligible resultant contribution to the odd-odd and even-odd *okl* reflections.

It thus seemed that these two sets of reflections owed their intensity to only three light

atoms. But among them were strong reflections comparable in intensity to the strong reflections in the other two sets. It was necessary that bromine contributes to all four sets in the *okl* reflections.

With the phases of the even-even and the odd-even fixed by the heavy atom, it was not difficult to determine enough signs in the other two sets to destroy the inevitable pseudo mirror symmetry of a heavy-atom-phased (100) electron density map.

An identification of the molecule in the resulting (100) electron density projection is shown in Fig. 2. The structure factor calculation shows satisfactory agreement between the

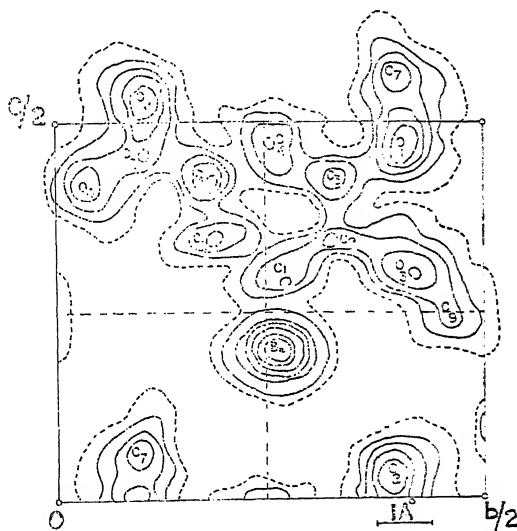


FIG. 2. (100) Electron density projection. observed and calculated values. The R-factor is only 0.20.

Table I gives the atomic co-ordinates in the (100) projection.

TABLE I  
Atomic co-ordinates in the (100) projection

Atom	<i>y</i>	<i>z</i>
Br	0.267	0.192
C $_1$	0.263	0.305
C $_2$	0.335	0.345
C $_3$	0.350	0.430
C $_4$	0.270	0.475
C $_5$	0.175	0.430
C $_6$	0.180	0.345
C $_7$	0.390	0.550
C $_8$	0.090	0.475
O $_1$	0.450	0.250
O $_2$	0.400	0.470
O $_3$	0.090	0.545
O $_4$	0.410	0.305
	0.040	0.430

The projection co-ordinates are being refined. The third ( $x$ ) co-ordinates have yet to be determined. But, even at this stage, it is apparent that the molecule has nearly a planar configuration. Only the  $O_3-C_9$  bond in the 4-methoxy group seems to be significantly off the general plane of the rest of the molecule.

Further work on the complete structure determination is in progress.

The authors wish to thank Dr. B. R. Pai, Professor of Chemistry, Presidency College, Madras, for kindly supplying a quantity of the substance.

Dept. of Physics,  
I.I.T., Madras-36,  
July 24, 1968.

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### PREPARATION OF O-NITRO- ACETANILIDE

THE direct nitration of acetanilide results in the formation of *para*-compound in preponderant quantity. Turner,<sup>1</sup> therefore, prepared the *ortho*-compound by first sulphonating the acetanilide so that the *para* position is occupied by the sulpho-group, the product was nitrated and then the sulphonic acid group was removed by hydrolysis. Witt and Utermann<sup>2</sup> have prepared *ortho*- and *para*-nitro-acetanilides by nitrating acetanilide, in glacial acetic acid medium, with nitric acid. Menke<sup>3</sup> synthesised O-nitro-acetanilide by treating aniline with copper nitrate in acetic anhydride medium. Roeder and Day<sup>4</sup> prepared this compound by acetylating O-nitro-aniline. Recently Itaya *et al.*<sup>5</sup> have prepared *ortho*-nitro-acetanilide by nitrating acetanilide with copper nitrate in acetic anhydride medium at 50° C.

During the course of our investigations, we have developed a simple method for the preparation of this compound in 95% yield.

**Experimental.**—One kilogram of acetanilide (7.408 Moles) was suspended in 5 litres of acetic anhydride (7.467 Moles) in a ten-litre open mouth stainless steel vessel fitted with an efficient stirrer, dropping funnel and a thermometer. The suspension was cooled in an ice-salt mixture. The suspension of the crystals was dissolved in subsequent reaction. 1.2 litres of  $HNO_3$ , sp. gr. 1.418, were cooled to 0–5° C. and added slowly into the cooled solution of acetanilide in acetic anhydride at 5° to 10° C. with vigorous stirring. The reaction

vessel was kept cool with mixture of ice and salt during the whole operation. The addition was completed in 5 hours and then the reaction mixture was allowed to stand for one hour with stirring. The reaction being exothermic, extreme precautions were taken not to allow the temperature of the mixture to rise, by slow addition of nitric acid and efficient cooling for two hours in the beginning when 1/3 of the acid was added, later on, the reaction proceeded smoothly. After completing the reaction, the reaction mixture was poured in ice-water when an orange-yellow precipitate of O-nitro-acetanilide separated.

The precipitate was filtered and washed with water till it was free from acid. The yield of the crude compound was 98%. The material was crystallised from hot water to get a pure O-nitro-acetanilide, m.p. 93° C. The weight of the pure material was 1267 gm. This method gives mainly O-nitro-acetanilide, the overall yield being 95%. The identity of the material was confirmed by estimation of nitro-group, carbon, hydrogen and nitrogen analysis, and by preparation of derivatives.

**Analysis:** Calculated for  $C_8H_7O_3N_2$ : C, 53.33; H, 4.44; N, 15.56.

**Found:** C, 53.45; H, 4.50; N, 15.51.

On hydrolysis with 10% HCl it gave O-nitro-aniline m.p. 72° C. and on reduction in neutral medium it gave O-azoxy-acetanilide, m.p. 185° C. Infrared spectrum was recorded on a Perkin Elmer Infracord model No. 137 using potassium bromide pellet. The I.R. spectrum was found identical with that of this compound prepared by Witt and Utermann<sup>2</sup> method, showing peaks at 5.9  $\mu$ , 6.65  $\mu$ , 7.42  $\mu$ . and 7.87  $\mu$ .

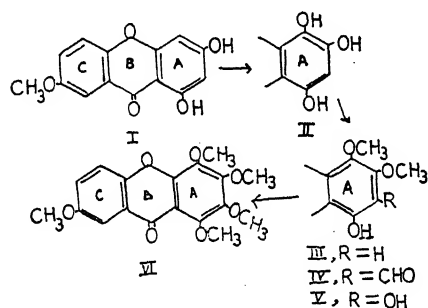
Explosives Research and Development Lab.,  
Kirkee, Poona-3 (India),  
May 18, 1968.

KUNWAR BAHADUR.  
W. D. PATWARDHAN.

1. Turner, *Ber.*, 1892, **25**, 986.
2. Witt and Utermann, *Ibid.*, 1906, **39**, 3901.
3. Menke, B., *Brit.*, 235698, May 1924.
4. Roeder, C. H. and Day, A. R., *J. Org. Chem.*, 1941, **6**, 25.
5. Motoichi Itaya *et al.*, *Nagoya Shiritsu Daigaku Yakuga-Kubu KIYO*, 1957, **5**, 54.

# A SYNTHESIS OF POLYGALAXANTHONE-B

POLYGALAXANTHONE-B was recently isolated from *Polygala pænea* L. (Polygalaceæ) and given the structure of 1, 2, 3, 4, 7-pentamethoxyxanthone (VI) on the basis of analytical and spectral studies.<sup>1</sup> This is the first example of this oxygenation pattern in xanthenes with ring A fully substituted with methoxyls, though analogous examples of 5, 6, 7, 8-tetra-substituted flavonoids are numerous. The pentamethoxyxanthone has now been synthesized employing methods of nuclear oxidation earlier used in the flavonoid group and the product agrees in all respects with the description of the natural xanthone. Hence the constitution of polygalaxanthone-B is confirmed.



The synthesis started from 1,3-dihydroxy-7-methoxyxanthone (I)<sup>2</sup>. Oxidation with alkaline persulphate gave 1, 3, 4-trihydroxy-7-methoxyxanthone (II, m.p. 298°) which was methylated partially with two moles of dimethyl sulphate in the presence of potassium carbonate and acetone. The resulting 1-hydroxy-3, 4, 7-trimethoxyxanthone (III, m.p. 182–83°) was subjected to hexamine condensation when the corresponding 2-aldehyde (IV, m.p. 218°) was obtained in nearly 50% yield. Subsequent Dakin oxidation with alkaline hydrogen peroxide gave 1,2-dihydroxy-3, 4, 7-trimethoxyxanthone (V, m.p. 238–40°) which on complete methylation gave polygalaxanthone-B (VI, m.p. 118–19°, R, 0.75 on silica gel G plate using CHCl<sub>3</sub>: MeOH, 97:3). The above synthesis also follows the possible path of biogenesis of polygalaxanthone which would involve double hydroxylation of the primary 1, 3, 7-trihydroxyxanthone (gentisein).

Dept. of Chemistry,  
University of Delhi,  
Delhi-7, June 25, 1968.

A. C. JAIN.  
V. K. KHANNA.  
T. R. SESHADRI.

1. Moron, J., Polonsky, J. and Pourrat, H., *Bull. Soc. Chim. Fr.*, 1967, p. 130.
2. Grover, P. K., Shah, G. D. and Shah, R. C., *J. Chem. Soc. Lond.*, 1955, p. 3982.

# CHEMICAL DIFFERENTIATION OF CASSIA TORA AND C. OBTUSIFOLIA AS TWO DISTINCT SPECIES

It is interesting to note that Singh<sup>1</sup> has presented some convincing experimental evidence from ecological studies of *Cassia tora* and *C. obtusifolia* to indicate that these are two distinct taxa. Here, I would like to cite an earlier reference of a paper by Rangaswami<sup>2</sup> in support of the view that the two species cannot be the same from 'biochemical' evidence obtained from a study of the chemical components of their seeds. The seeds of *C. tora*<sup>3</sup> contain rubrofusarin and non-rubrofusarin which belong to the class of naphthopyrones, while the seeds of *C. obtusifolia*<sup>4</sup> contain closely related compounds—chrysophanol, physcion, obtusin, obtusifolin, chryso-obtusin and aurantio-obtusin, all of which are anthraquinones. Chemically these groups are different, and we have a clear case of applications of chemical analysis regarding synonymy or otherwise in botanical nomenclature. In recent years, chemical plant taxonomy<sup>5</sup> (biochemical systematics<sup>6</sup>) has created great interest, bringing together phytochemists and systematic botanists closer for better team work.

Dept. of Chem., S. SANKARA SUBRAMANYAN.  
Jipmer, Pondicherry-6,  
July 10, 1968.

1. Singh, J. S., *Curr. Sci.*, 1968, **37**, 381.
2. Rangaswami, S., *Bull. Natl. Inst. Sci. (India)*, 1967, **34**, 158.
3. —, *Proc. Ind. Acad. Sci.*, 1963, **57A**, 88.
4. Takido, M., *Chem. Pharm. Bull.*, 1958, **6**, 397 ; 1960, **8**, 246.
5. Swain, T. (Editor), *Chemical Plant Taxonomy*, Academic Press, London, 1963.
6. Alston, R. E. and Turner, B. L., *Biochemical Systematics*, Prentice Hall, Englewood Cliffs, U.S.A., 1963.

# MICROBIAL TRANSFORMATIONS OF TERPENOIDS—CITRONELLAL

MOLINARI,<sup>1</sup> Seubert,<sup>2</sup> and Hayashi et al.<sup>3</sup> have reported the isolation of only citronellic acid by the fermentation of citronella in an inorganic salt medium with *Acetobacter xylinum*, *Pseudomonas citronellolis* and *Pseudomonas aeruginosa* respectively,

In the present investigation one of the organisms isolated from the local soil by the enrichment culture techniques, and identified as *Pseudomonas aeruginosa* was found to be capable of fermenting citronellal. Using Cubert's<sup>2</sup> medium containing inorganic salts, ammonium nitrate and pure citronellal fermentation was carried out on a rotary shaker at  $30 \pm 1^\circ \text{C}$ . for four days. The pooled fermented broth was acidified and extracted with ether and chloroform and the acidic fraction was separated by aqueous sodium carbonate. The transformation products were then isolated and purified by the modified Craig's countercurrent distribution method and by column chromatography. The isolated products were monitored by thin layer and by liquid chromatography and identified by IR, UV, NMR, and chemical degradation methods.

In addition to citronellal acid four other products have been identified among the transformation products, namely, citronellol, dihydrocitronellol, menthol and 2:6 dimethyl, 10-en-6, 8-diol. Pregrowing the culture on different substrates has been found to affect the yields of these metabolites.

Maharashtra Association      S. S. JOGLEKAR.  
for the Cultivation          R. S. DHAVALIKAR.  
of Science,  
Puna-4, May 28, 1968.

- Molinari, E., *Biochem. Z.*, 1929, **216**, 187.
- Seubert, W., *Jour. of Bact.*, 1960, **79**, 426.
- Hayashi, T., Hirano, K., Ueda, H. and Tatsumi, C., *Nippon. Noei Kagaku Kaishi*, 1967, **41**, 247; *C.A.*, 1967, **67**, 79877f.

## USE OF BACTERIAL FERTILIZERS IN CROP PRODUCTION IN U.P.

The drive for increased production of crop is presently being handicapped by a shortage of fertilizers and attempts are being made to solve substitutes for these. Lately use of bacterial fertilizers, comprising of bacterial inoculants specially *Azotobacter* species or use of phosphorus solubilising organisms, viz., *Bacillus megatherium* var. *phosphaticum*, in U.P. has been greatly publicised principally in S.S.R. and to some extent in other agriculturally advanced countries.<sup>1-4</sup> Indian Agricultural Research Institute has taken a lead in this direction and has obtained a number of such bacterial inoculants some of which have been found useful.

Trials on these bacterial inoculants were also conducted in Uttar Pradesh from bacterial cultures obtained from the Microbiology Division, IARI. Field experiments with bacterial inoculums were conducted on nutrient depleted soils of the State, well known for their responsiveness to fertilizer treatments. Initial fertility status of the soil under different experiments are given in Table I. The experiments with both bacterial cultures during the first year were

TABLE I  
Initial fertility status of soils under different experiments

Particulars	Phosphobacterin experiments		Azotobacterin experiments
	Wheat 1963-64	Berseem 1964-65 and 1965-66	Wheat 1963-64
pH	6.8	6.6	6.8
Available $\text{P}_2\text{O}_5$ lb./acre	28.0	17.6	28.0
Total nitrogen per cent.	0.065	0.055	0.065
Organic carbon per cent.	0.55	0.45	0.55

conducted on wheat crop but during the subsequent years phosphobacterin experiments were conducted only on berseem crop. The seed of wheat grain or berseem was inoculated with these cultures under moist conditions and sown in the field under three levels of fertility. The fields were well prepared and the crop sown in the usual manner. Sufficient organic matter, consisting of well-rotted farm-yard manure, was applied as a basal dressing to the field prior to the sowing of crop. The phosphobacterin experiment was conducted with eight treatments covering its use alone as well as in combination with other phosphate-carrying nutrients including superphosphate, bone-meal and rock phosphate. The treatments were replicated four times in both the crops which were being tested. Berseem experiments were conducted in the same field in two consecutive years.

Inoculation studies with azotobacterin conducted on wheat crop included six treatments covering *Azotobacter* alone compared against a soil treated with high doses of organic matter singly as well as in association with superphosphate. The results obtained from the two studies are presented in Table II for phosphobacterin and in Table III for azotobacterin. The yield results are expressed in term of kg. per hectare for grain in wheat and green matter as fodder in berseem crop.

TABLE II  
Effect of phosphobacterin inoculation on  
yield of crop

Treatments	Wheat 1963-64 average for 4 replica- tions	Yield in kg./hectare	
		Berseem 1964-65 3 cuttings	1965-66 2 cuttings
Control ..	1620	58830	7065
Phosphobacterin ..	1429	57380	7152
P 68 (Superphosphate) ..	2018	57190	1732
P 68 (Superphosphate) + Phosphobacterin ..	2029	61700	21806
P 68 (Bone-meal) ..	1586	53540	9675
P 68 (Bone-meal) + Phos- phobacterin ..	1300	52050	7305
P 68 (Rock phosphate) ..	1535	56640	7960
P 68 (Rock phosphate) + Phosphobacterin ..	1518	60550	7336
S.E. ..	167	3512	2054
C.D. at 5% ..	347	7305	4272

P 68 = 68 kg.  $P_2O_5$ /hectare.TABLE III  
Effect of azotobacterin inoculation on the  
yield of wheat crop (1963-64)

Treatments	Grain kg/ hectare
Control ..	840
Soil + <i>Azotobacter</i> ..	893
Soil + 12,000 kg./hectare f.y.m. ..	1099
Soil + 12,000 kg./hectare f.y.m. + <i>Azotobacter</i> ..	997
Soil + 12,000 kg./hectare f.y.m. + P 68 (Superphosphate) ..	1137
Soil + 12,000 kg./hectare f.y.m. + P 68 (Superphosphate) + <i>Azotobacterin</i> ..	1020
S.E. ..	83.5
C.D. at 5% ..	178

The data in Tables I-III would indicate that phosphobacterin inoculation initially failed to show any effect on the yield of wheat crop, even in a highly responsive soil. Its effectiveness, however, becomes perceptible when a legume crop (berseem) was selected for these studies and a marked increase in yield was obtained from its inoculation under high fertility conditions in presence of readily available phosphorus from single superphosphate. These effects became more pronounced during the succeeding year (1965-66) in which the experiment was repeated in the same field with the same lay-out. In this marked responses have been recorded either from phosphobacterin alone and more conspicuously in presence of a source of readily available soluble phosphorus.

In regard to the effects of azotobacterin it is evident that no marked effects of inoculation have been observed on wheat crop, under the environmental conditions of the present studies. The experimental study deserves more attention and calls for investigation with more and better effective cultures and more favourable environmental conditions.

The co-operation extended by Dr. W. V. B. Sundara Rao, Head of the Division of Microbiology, Indian Agricultural Research Institute, New Delhi, in affording the bacterial cultures and initiating the field studies are gratefully acknowledged.

Office of the Agricultural Chemist (U.P.),  
Kanpur, November 10, 1967.

L. K. LALHA.

C. L. MEHROTRA.

1. Cooper, R., "Bacterial fertilizers in the United States and Fertilizers, 1959, 22 (327), 333.
2. Menkina, R. A., "Bacterial fertilizers and their importance for agricultural plants," *Microbiol. Rev.*, 1963, 33, 352.
3. Rubenchik, L., "Bacterial fertilizers," *ibid.*, 1963, 25, 231.
4. Smith *et al.*, "Evaluation of phosphobacterin as a soil inoculant," *Soil Sci. Soc. Amer. Proc.*, 1961, 25, 109.

#### EFFECT OF VIOMYCIN ADAPTATION ON GLUCOSE DEHYDROGENASE AND PYRUVIC ACID CARBOXYLASE ACTIVITY OF *AEROBACTER* *AEROGENES*

WHEN a normal culture of *Aerobacter aerogenes* is serially passed through a medium containing increasing concentrations of viomycin, resistant strains of the organism develop. This phenomenon of adaptive response thus developed has been explained<sup>1-4</sup> as due to the enzyme balance of the cells. Changes occurring in nucleic acid, protein content, and enzymatic activity of normal, viomycin-trained, and reverted strains of *Aerobacter aerogenes* during their growth have been reported by the authors.<sup>5-7</sup> In continuation of the above, in the present report, glucose dehydrogenase and pyruvic acid carboxylase activity in the same strains have been studied and compared.

Thunberg technique<sup>8</sup> was employed for the determination of glucose dehydrogenase activity by finding the rate of reduction of methylene blue. The main tube contained 2 ml. phosphate buffer (pH 7.4), and 2 ml. 0.02 M glucose solution; 0.1 ml. of the cell suspension (250  $\mu$ g./ml.) was put in the hollow stopper. The tubes were evacuated, filled

with nitrogen and immersed in a thermostat bath at  $40^{\circ} \pm 0.1^{\circ}\text{C}$ . After ten minutes the tubes were tilted so as to mix the solution and the cell suspension. The reduction rate of methylene blue was noted by Klett's absorptiometer with red filter. The results were expressed as  $(a-x)$  to represent the reduction of methylene blue, where 'a' was the initial reading at 'O' hour and 'x' the reading after time 't'.

The manometric method used by Warburg *et al.*<sup>9</sup> has been employed for the estimation of pyruvic acid carboligase activity. In the main chamber 1.0 ml. of the pyruvate solution (10 mg. sodium pyruvate per 100 ml. of the phosphate buffer pH 5.8), 0.5 ml. magnesium sulphate (0.20%) and 0.5 ml. of the phosphate buffer were taken. 0.2 ml. of the cell suspension (390  $\mu\text{g./ml.}$ ) was put in the side arm. The thermobarometer flask contained the same substances except the pyruvate solution which was replaced by 1.0 ml. of the phosphate buffer. The contents of the flasks were mixed and readings taken every five minutes.

Figures 1 and 2 show the glucose dehydrogenase and pyruvic acid carboligase activity respectively in the normal, viomycin-trained and reverted cultures with progress of time. It has been found that the rate of decomposition of pyruvic acid is more in the case of viomycin-trained culture than the normal and reverted cultures. This is also true when the glucose dehydrogenase activity is measured (Fig. 1). It is thus indicated that as a result of training in the medium having viomycin

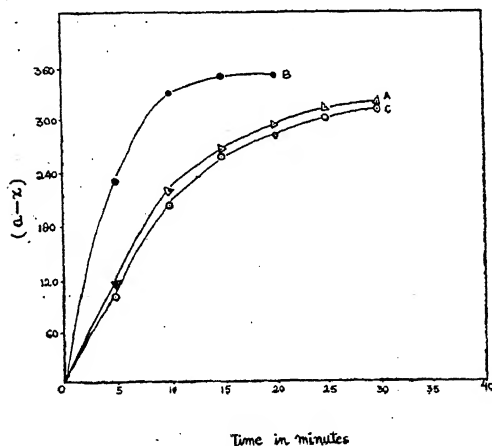


FIG. 1. Glucose dehydrogenase activity in *A. aerogenes*: (A) Normal culture, (B) Viomycin-trained culture and (C) Reverted culture.

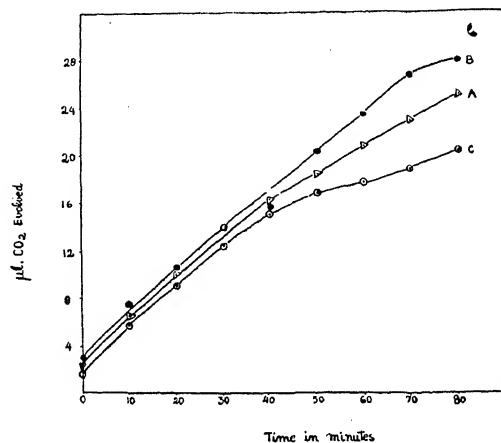


FIG. 2. Pyruvic acid carboligase activity in *A. aerogenes*: (A) Normal culture, (B) Viomycin-trained culture and (C) Reverted culture.

the enzyme activity increases while the viomycin-trained culture when passaged in viomycin-free medium, the activity falls rapidly. This behaviour of *Aerobacter aerogenes* under the action of viomycin seems to be a case of adaptation which is acquired temporarily.

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G.S.V.M. Medical College, J. P. SHUKLA.\*  
Kanpur, May 29, 1968.

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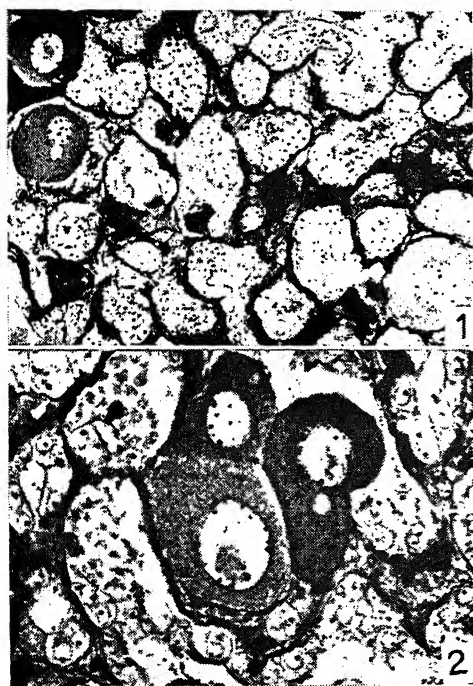
1. Lodge, R. M. and Hinshelwood, C. N., *J. Chem. Soc.*, 1943, p. 208.
2. Davies, D. S. and Hinshelwood, C. N., *Trans Faraday Soc.*, 1943, **39**, 431.
3. —, — and Pryce, J. M. G., *Ibid.*, 1944, **40**, 397.
4. Hinshelwood, C. N. and Lodge, R. M., *Proc. Roy. Soc.*, 1944, **132 B**, 47.
5. Agarwal, K. C. and Shukla, J. P., *Proc. Ind. Acad. Sci.*, 1967, **65**, 192.
6. — and —, *Ind. J. Expt. Biol.*, 1965, **3**, 180.
7. — and —, *Proc. Ind. Acad. Sci.*, 1967, **66**, 226.
8. Umbreit, W. W., Burris, R. A. and Stauffer, J. F., *Manometric Techniques*, Burgess Publishing Co., 1964, p. 230.
9. Warburg, O., Kubowitz, F. and Christian, W., *Biochem. Z.*, 1930, **227**, 252.

## HERMAPHRODITISM IN A TELEOST, *NOTOPTERUS NOTOPTERUS* (PALLAS)

AN interesting case of hermaphroditism has been encountered in a specimen of *Notopterus notopterus* during the course of investigations on spermatogenesis. The specimen was collected in the month of June (breeding season) in 1964. The fish has a single gonad

lying on the left side of the stomach, in the body cavity. In this hermaphrodite specimen the gonad shows all the essential characters of the testis which is a laterally compressed structure, with a sperm duct running all along its length on the posterior margin. On further examination of the micro-sections of this organ, it proves to be a hermaphrodite organ, the ovo-testis.

The testicular region of the ovo-testis consists chiefly of a connective tissue which extends inwards from the periphery at several places forming stroma and dividing the testis into a number of lobules. The lobules are further divided into smaller chambers, the cysts which contain the male germ cells of various stages of spermatogenesis. Several developing oocytes are found scattered in the testicular tissue. Generally these oocytes are located in the seminiferous lobules in solitary state (Fig. 1). But at certain places they are grouped together so as to form the ovarian tissue (Fig. 2). The oocytes of the ovo-testis



FIGS. 1-2

can be categorised in three successive developing stages of oogenesis as seen in the ovary of female *Notopterus notopterus*. The oocyte of stage 1, is a slightly enlarged germ cell measuring 10 to 15  $\mu$  in diameter. It is differentiated

from the spermatogonia in having thicker cytoplasmic sheath which takes deep blue colour when stained with iron haematoxylin. The nucleus contains only single nucleolus and clearly discernible chromatin threads. The oocyte of stage 2, grows in size by developing a thicker coat of cytoplasm around the nucleus. It measures 25 to 35  $\mu$  in diameter. Nucleoli increase in number and are found scattered in the nucleoplasm. The oocyte of stage 3 appears quite uniformly granular and measures 64 to 70  $\mu$  in diameter. The centrally located nucleus is also considerably enlarged and its nucleoli, at this stage, can be differentiated into two categories of smaller and bigger sizes. The bigger nucleoli are arranged in a circle below the nuclear membrane. This stage is a quite advanced stage of oogenesis and can be compared with the 'perinuclear stage' of the oocyte which has been studied in the ovary.

Hermaphroditism is not a rare occurrence in teleosts. Literature on hermaphroditism reveals that there exists a great variation in the disposition and relation of testicular and ovarian tissues. In *Clarias batrachus*<sup>3</sup> the ovarian and testicular regions are clearly demarcated, and connected only by a narrow bridge. In *Rastrelliger canagurta*,<sup>4</sup> *Hilsa ilisha*,<sup>1</sup> *Cirrhitidae*,<sup>6</sup> and *Huro salmoides*,<sup>2</sup> the hermaphrodite organs have been also described as having a distinct differentiation of testicular and ovarian tissues. On the other hand, in *Barbus stigma*,<sup>5</sup> *Lebistes reticularis*,<sup>7</sup> and *Mystus vittatus*<sup>7</sup> the oocytes are scattered in solitary state in the testicular tissue. In *Notopterus notopterus* the oocytes are scattered in some areas of the ovo-testis in a solitary state, while in the other areas, the ovarian tissues are clearly distinguished due to the grouping of oocytes. Thus, the present case, in this fish, can be considered as an intermediate condition which, as far as the author is aware, has not been reported so far in any other teleost. From this it can be inferred that some of the spermatogonia, instead of converting into spermatocytes, develop into early stages of the oocytes which in turn group together to form ovarian tissues.

I am grateful to Professor H. Swarup for his keen interest and guidance.

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December 30, 1967.

S. S. SHRIVASTAVA,

1. Chacko, P. I. and Krishna Murthy, B., *Proc. 36th Ind. Sci. Cong. Abst.*, 1949, p. 167.
2. James, F. M., *J. Morph.*, 1946, **79**, 93.
3. Lehri, G. K., *Curr. Sci.*, 1964, **33**, 530.
4. Prabhu, M. S. and Raja, B. T., *Ibid.*, 1958, p. 16.
5. Sathyanesan, A. G., *Sci. and Cult.* 1957, **23**, 203.
6. — and Ranga Rajan, K., *Proc. 40th Ind. Cong. Abst.*, 1953, p. 208.
7. Singh, T. P. and Sathyanesan, A. G., *Curr. Sci.*, 1961, **30**, 285.
8. Spurway, H., *Nature*, 1957, **180**, 1248.

### CHROMATOPHOROTROPINS IN THE EYESTALK AND BRAIN OF THE HERMIT CRAB, *DIODES BICRISTIMANUS*.

DETERMINATION of the properties and number of chromatophorotropins present in the different crustaceans is important in a comparative physiological point of view. Very little is known about the chromatophorotropins of hermit crabs. So far the chromatophorotropins of only one hermit crab, *Pagurus* are investigated.<sup>1-4</sup> The eyestalks of *Pagurus* contain principles evoking concentration of the dark pigments in *Craugon*<sup>1</sup> and *Palaemonetes*<sup>2</sup> and disperse the melanin in the chromatophores of *Uca*.<sup>3</sup> However, it is not known whether the eyestalks of hermit crabs contain principles affecting the red and white chromatophores of the brachyurans, and whether the central nervous system of hermit crabs contain principles affecting the chromatophores of brachyurans. The following study provides answers to these questions.

Specimens of *Diodes* collected from the Lawson's Bay, Waltair, were used in this study. From the freshly dissected eyestalks, brain and abdominal muscle of *Diodes* sea-water extracts (SWE), ethyl alcohol soluble (ASF) and insoluble (AIF) fractions, acetone soluble (ACSF) and insoluble (ACIF) fractions were prepared.<sup>5-6</sup> The final concentration of the extracts was: 2 eyestalks per 0.05 ml., 1 brain per 0.05 ml., and 2 mg. muscle per 0.05 ml. Each extract was injected into 5 eyestalkless *Ocypode macrocera* and 5 intact *Ocypode macrocera* adapted to a white background for two hours. The dose of injection was 0.05 ml. per crab. Using the above two types of assay crabs it is possible to determine the black pigment-dispersing (BPDH), red pigment-dispersing (RPDH), white pigment-dispersing (WPDH), red pigment-concentrating (RPCH) and white pigment-concentrating (WPCH) activities of the extracts. The states of

pigment dispersion in the chromatosomes of *Ocypode* were recorded at the start of the experiment and at 5, 15, 30 minutes after the injection of the extract, and at 30 minute intervals thereafter for the duration of the effect, following the scheme of Hogben and Slome.<sup>7</sup> The chromatophorotropic potencies of the extracts were calculated and expressed as activity values.<sup>8</sup> Each experiment was repeated once. All the experiments were conducted during the daytime at a temperature of 27 to 29° C., under an illumination of 40 f.c. light intensity.

None of the muscle extracts showed any chromatophorotropic activity. The results shown in Fig. 1 reveal that the sea-water extracts of the eyestalks and brain of *Diodes*

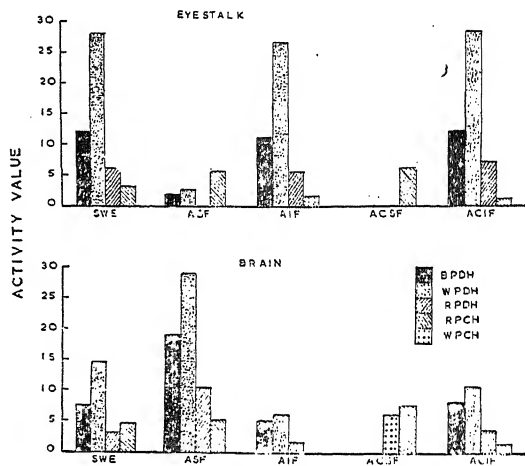


FIG. 1. The chromatophorotropic activities of the extracts of eyestalks and brain of the hermit crab, *Diodes bicristimanus* as assayed on the crab, *Ocypode macrocera*. Explanation to the abbreviations given in the text.

evoke dispersion of the black, red and white pigments, and concentration of the red pigment in the chromatosomes of *Ocypode*. The pigment-dispersing principles in the eyestalk of *Diodes* appear to be different from those in the brain. The pigment-dispersing principles in the eyestalk are relatively insoluble in ethyl alcohol, whereas those in the brain are soluble in ethyl alcohol. Furthermore, the alcohol-soluble fraction of the brain seems to have much more pigment-dispersing activity than the sea-water extract, analogous with the situation recorded for the eyestalk ganglia of the crab, *Ocypode macrocera*.<sup>8</sup> The pigment-dispersing substances in the eyestalk and brain



of *Diogenes* are insoluble in acetone. However, the red pigment-concentrating substance is soluble in acetone and alcohol. The white pigment-concentrating substance is present in the brain of *Diogenes*, but it is demonstrable only after fractionating the brain with acetone. None of the eyestalk extracts tested had white pigment-concentrating activity.

This investigation was carried out in the Zoology Department of the Andhra University, Waltair. The author is thankful to Prof. P. N. Ganapati for providing facilities and Dr. Nagabhushanam for his helpful suggestions.

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1. Perkins, E. B. and Kropp, B., *Rep. Mt. Desert Isl. Biol. Lab.*, 1933, p. 24.
2. Hanström, B., *Kgl. Svenska Vetenskapsakad. Handl.*, 1937, Ser. III, 16, 1.
3. Abramowitz, A. A., *Biol. Bull.*, 1937, 72, 344.
4. Brown, F. A. Jr. and Saigh, L. M., *Ibid.*, 1946, 91, 170.
5. Rao, K. R., *Naturwiss.*, 1967, 54, 26.
6. —, Fingerhagen, M. and Bartell, C. K., *Biol. Bull.*, 1967, 133, 606.
7. Hogben, L. T. and Slome, D., *Proc. Roy. Soc. (London)*, 1931, 108 B, 10.
8. Rao, K. R., *Physiol. Zool.*, 1967, 40, 361.

## THE PHYSIOLOGY OF THE WOOD-LOUSE, *PORCELLIO LAEVIS* LATREILLE (PORCELLIONIDAE, PERACARIDA)

### II. The Occurrence of the Goblet Cells in the Gut Epithelium\*

The occurrence of the goblet cells in the midgut epithelium of a number of lepidopterous larvæ has been reported by Waterhouse.<sup>5</sup> In these cells, the cytoplasm is reduced and the cell surface with its striated border is invaginated to form a deep cavity;<sup>3</sup> or, alternatively, the cavity with striated border is formed within the developing cell.<sup>8</sup>

The anatomy of the crustacean alimentary canal has been studied extensively,<sup>7</sup> but the existence of the goblet cells in these animals has never been reported.

*Porcellio laevis*, used for cytological work, was reared in a glass tank containing moist sterilized white sand and the decaying roots

of *Typha latifolia* L. To minimize individual variations only young adults were used. The isopods were dissected alive in Bodenstein's Insect Ringer and their alimentary canals were removed. These alimentary canals were fixed in Bouin's fluid, dehydrated, and placed in cedar wood oil. After wax embedding, serial sections 6–8  $\mu$  were cut and stained with Delafield's hæmatoxylin and Mallory's triple stain.

As shown in Fig. 1, *Porcellio* gut is made up of a delicate chitinous membrane, laid down

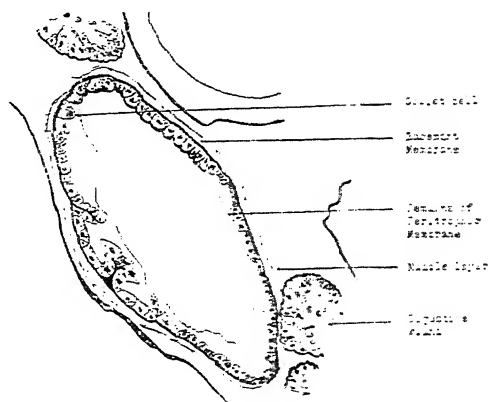


FIG. 1. Transverse section of the midgut of the young adult male of *Porcellio laevis* Latreille. (Enlarged 5 × 4 times).

by cubical epithelial cells resting on a thin basement membrane. Outside this there is a relatively thick muscular covering consisting of the longitudinal muscles to the inside and the circular muscles to the outside; the whole enclosed in a connective tissue sheath.

Goblet cells are not very numerous in the *Porcellio* gut, and the majority of them (from 85 to 92%) are concentrated in the posterior one-third of the midgut. Others are distributed randomly in the anterior half of the hind-gut. Where they are most numerous they lie very close together, occasionally side by side, but frequently are separated by at least one normal cell.

The goblet cell (Fig. 2) is generally narrower at the base and somewhat circular in shape towards the lumen of the gut. More than half of the cell, generally the one nearer to the gut lumen, is occupied by a large, roughly spherical vacuole. The large, granular nucleus lies in the distal half of the cell, immediately above the base of the vacuole. The cytoplasm surrounding the nucleus is relatively thinner and lacks the rod-like elements of the cytoplasm of the normal mature cell.

\* Contribution No. 3.

It, however, thickens towards the apical part of the cell but again loses its thickness at the extreme apex where the cavity extends very nearly to the tip of the apical protrusion. An opening at the apex of the vacuole into the gut lumen was never observed.

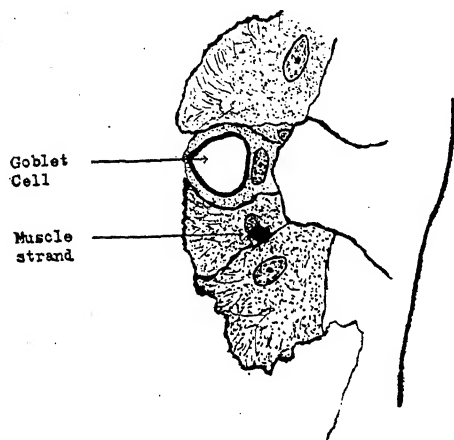


FIG. 2. Epithelium of the midgut of *Porcellio laevis* Latreille. (Enlarged  $40 \times 4$  times).

No satisfactory function has been ascribed to these goblet cells. By some workers they are regarded merely as a resting or senescent stage of the normal cubical cells,<sup>2,5</sup> while others<sup>3</sup> consider them as quite distinct, arising independently from the embryonic cells. Henson<sup>3</sup> reports that both types are present in the newly hatched larvæ of *Vanessa*, and, according to Tchang,<sup>6</sup> these two types of the goblet cell can be noticed even during the last few days of the embryonic life of *Galleria*. However, this does not exclude the possibility of their being exhausted cells, for even at this stage digestion of the yolk and of the egg-shell has begun.<sup>8</sup>

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1. Bodenstein, D., *Biol. Bull.*, 1946, 90, 148.
2. Deegener, P., *Arch. Naturgesch.*, 1909, 75, 71.
3. Henson, H., *Quart. J. Micr. Sci.*, 1931, 74, 321.
4. Jeuniaux, C., *Arch. Intern. Physiol. & Biochim.*, 1956, 64, 583.

5. Shinoda, O., *Z. Zellforsch. Mikr. Anat.*, 1927, 5, 278.
6. Tchang, Yung-Tai, *Bull. Soc. Zool. Fr.*, 1928, 53, 56.
7. von Buddenbrock, W., In *Vergleichende Physiologie*, Basel, Birkhauser, 1956, 3, 677.
8. Waterhouse, D. F., *Aust. J. Sci. Res. (B)*, 1952, 5, 169.

### EXPERIMENTAL PROSTHOGONIMUS OVATUS INFECTION IN THE DOMESTIC PIGEONS

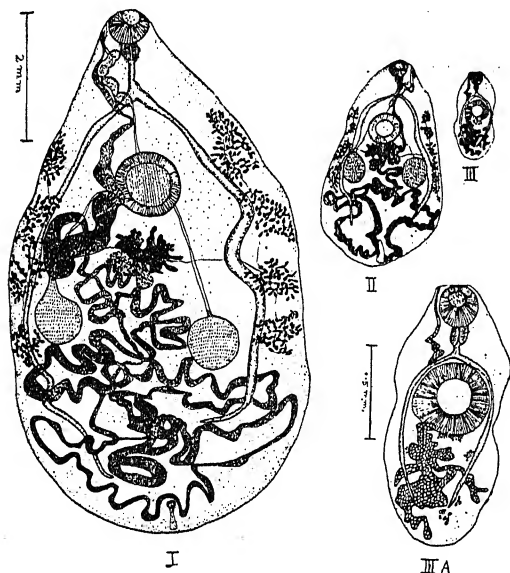
*Prosthogonimus*, a cosmopolitan trematode genus along with a considerable number of species named under it, occurs in the Bursa Fabricii, cloaca and oviduct of a large number of birds—wild and domestic. Its occurrence in the reproductive system of domestic poultry is of particular significance. Information on the different aspects of pathogenicity is available.<sup>1,5</sup> Seven species of the local Libellulid dragonflies act as second intermediate hosts of a prosthogonimid fluke.<sup>4</sup> These metacercariae successfully developed, in experimental clean chicks<sup>3</sup> and in two laying white leghorn hens,<sup>4</sup> to the adults identified as belonging to *P. putschkowskii* now included as one of the 28 synonyms of *P. ovatus*.<sup>2</sup>

Domestic pigeons—two females and four males—were fed encysted metacercariae available from the naturally infested specimens of *Brachythemis contaminata* (Fabr.) and *Orthetrum sabina* (Drury). The flukes, recovered after autopsy, were studied from their stained permanent mounts. The data presented below include an aspect of biology in the host-parasite relationship of this important fluke as revealed by the sex-difference in a susceptible definitive host.

Of the two female pigeons, one was exposed to 87 metacercariae and the other was fed 125. The droppings became positive for the characteristic eggs on the sixteenth day after infection. From the first infected pigeon autopsied on the 29th day, seventeen adult specimens were collected from different sites—4 from the uterus and 3 from the magnum of the oviduct, 2 from its external surface; 3 from the Bursa Fabricii and 2 from the cloaca; 3 from over the intestinal coils. Of the 30 flukes available from the other female pigeon, 4 were collected from the magnum and 3 from the uterus of the oviduct and one from the cloaca. The remaining 22—those that had migrated out of the oviduct, included 3 found on the external surface of the oviduct, 1 lying over the ovary,

2 inside the left abdominal air-sac, 15 moving over the coils of the intestine and one lying on the gizzard. The entire oviduct was fully intact. All these specimens (Fig. 1), in morphological details, conformed to the similarly-aged material recovered from the experimental chicks.

The four male pigeons administered the metacercarial dose of 102, 60, 83 and 35 were slaughtered on the 20th, 30th, 29th and 10th day after infection respectively. The first two pigeons alone had picked up the infection. 20 flukes that were recovered from the Bursa Fabricii of the first pigeon were 20-day old and, though fully mature (Fig. 2), had a comparatively much smaller size than the specimens of the same age obtained from the chicks. From the second case, the cloaca yielded 3 worms. These 30-day-old specimens were considerably of diminutive size. In addition to the two suckers and the different parts of the digestive system, the uterus with normal eggs alone represented the reproductive system in which the remnants of the ovary and the tests were discernible as small cellular masses (Figs. 3 and 3A).



FIGS. 1-3

The observations show that female pigeons can act as an appropriate host for experimental studies with this important oviductal fluke of the poultry. Once established in the oviduct, *Prosthogonimus* has the unique feature of

migrating, among the viscera, after emergence through the fallopian tube. Similar observations regarding the migration of the flukes, through the normal proximal opening of the oviduct, were encountered in a laying hen. The previous reports of finding flukes in the abdominal cavity are from the rupture of oviduct leading in some cases to peritonitis. This condition, as stated previously, was absent in the cases reported herein. The male birds, on the other hand, appear comparatively refractory as only two of the infected birds had picked up the infection. Those that had reached maturity had subsequently shrivelled up and, with atrophied reproductive organs, seem to pass out later. The cloacal collection of the three specimens appeared to be on its way to the exterior. Additional data on the lesions in the attacked regions of the oviduct in these 2 different species of the definitive hosts and in the ectopic foci in consequence of migration including histopathology are dealt with elsewhere.

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December 30, 1967.

1. Biester, H. E. and Schwarte, L. H., *Diseases of Poultry*, The Iowa State University Press, Ames., Iowa, U.S.A., 1965, p. 1382.
2. Boddeke, R., *Trop. Geo. Med. Amsterdam*, 1960, 12, 375; *Vide Helm. Abs.*, 1961, 30, 1942.
3. Mishra, G. S. and Pande, B. P., *Ind. J. Vet. Sci.*, 1967, 37, 156.
4. Prakash, R. and Pande, B. P., *Ind. Vet. J.*, 1968, (In press).
5. Soulsby, E. J. L., *Text-Book of Veterinary Clinical Parasitology. I. Helminths*, Blackwell Scientific Publications, Oxford, 1965, p. 1120.

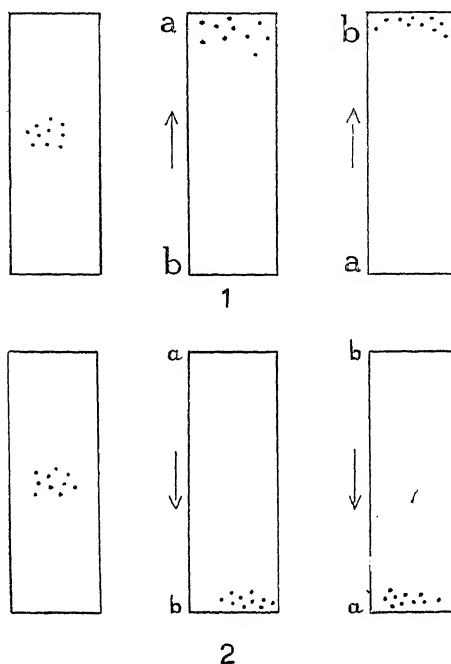
## RESPONSES OF TERMITES (INSECTA: ISOPTERA) TO GRAVITY

GRAVITY is one of the important environmental factors for terrestrial animals. No work appears to have been carried out on gravity responses of subterranean and drywood termites. In nature, while the subterranean termites live in soil, drywood termites inhabit wooden material, such as trees, rafters, etc., without maintaining any connection with the soil. It was, therefore, thought desirable to conduct experiments to find out if the basic differences of habitat of subterranean and

drywood termites influence their responses to gravity.

For this purpose, two species, one subterranean termite (*Microcerotermes beesonii* Snyder, family Termitidae, subfamily Amitermitinae) and one non-subterranean drywood termite (*Neotermes bosei* Snyder, family Kalotermitidae) were selected. The subterranean termite, *M. beesonii*, builds wood-carton nests which remain partially buried in the soil. This species commonly occurs in the 'sal' (*Shorea robusta*) forests in the neighbourhood of Dehra Dun.<sup>1</sup> *N. bosei* inhabits dead branches of certain living trees in Dehra Dun,<sup>2</sup> but it attacks drywood under laboratory conditions.<sup>3</sup> Worker caste was used in case of *M. beesonii*. *N. bosei* has no worker caste whose functions are performed by grub-like pseudo-workers<sup>4</sup> which were used.

Two sets of experiments, one set for the subterranean termites and another for the drywood termites, were carried out. All the experiments were conducted in the culture room having a temperature of  $28 \pm 1^\circ\text{C}$  and relative humidity of  $90 \pm 5\%$ . In each set of experiment, 10 workers for *M. beesonii* or 10 pseudoworkers for *N. bosei* were placed on a sheet of cardboard on the middle and their original positions were marked on another sheet of the same dimension. The cardboard sheet with the termites was kept in a vertical position in complete darkness for 10 minutes after which light was switched on and the new positions of termites were marked again on another sheet. The cardboard sheet was reversed upside down and left again in complete darkness for 10 minutes after which the new positions were similarly marked again. Experiments with each termite species were replicated ten times, each time with different groups of termites. The results have been depicted in Figs. 1 and 2. The same results were obtained using glass plates with grounded surface instead of cardboard sheets. It will be seen from these figures that while workers of *M. beesonii*, the subterranean termite, exhibited negatively geotropic responses and always moved upwards, the pseudoworkers of *N. bosei*, the drywood termite, invariably moved downwards indicating positive geotropic responses under the experimental conditions. This difference of behaviour can be explained on the basis of the basic difference in habitats of the two species of test termites as explained earlier.



FIGS. 1-2. Fig. 1. Responses of workers of *Microcerotermes beesonii* Snyder to gravity. Termites were negatively geotropic. Fig. 2. Responses of pseudoworkers of *Neotermes bosei* Snyder to gravity. Termites were positively geotropic.

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1. Mathur, R. N. and Sen-Sarma, P. K., *Jour. Timber Dryers' and Preservers' Assoc. India*, 1960, **6**, 23.
2. Roonwal, M. L. and Sen-Sarma, P. K., *Jour. Bombay Nat. Hist. Soc.*, 1955, **53**, 234.
3. Sen-Sarma, P. K. and Chatterjee, P. N., *Indian Forester*, 1965, **91**, 805.
4. Roonwal, M. L. and Sen-Sarma, P. K., In *Contributions to the Systematics of Oriental Termites*, Manager of Publication, Govt. of India, Delhi, 1965, p. 407.

#### OCCURRENCE OF INHIBITORS IN RICE LEAVES

ACCORDING to the "Inhibitory theory of specificity"<sup>1</sup> inhibitors in a plant govern the specificity of plant pathogens. *Helminthosporium oryzae* Breda de Haan, the blight pathogen of paddy (*Oryza sativa* L.) specifically parasitizes rice while other species are not pathogenic on rice. In this note, the occurrence of inhibitors in rice plants is reported.

The cultivar CO.19 grown in cement pots under field conditions was used. 100 g. of 15-day-

old leaves were chopped and suspended in 400 ml. of boiling acetone for 5 minutes. The residue was re-extracted in 100 ml. of hot acetone. The extracts were pooled, clarified by filtration, concentrated by flash evaporation and the volume was adjusted to represent 10 g. material in 1 ml. The extract was tested for its ability to inhibit the spore germination of *Helminthosporium* spp. obtained from the Commonwealth Mycological Institute, Kew, England, and the results are shown in Table I. The extract markedly inhibited the spore germination of the non-pathogens and caused malformation of germ tubes of germinating spores including *H. oryzae* (Fig. 1).

TABLE I

Effect of acetone extract on spore germination of *Helminthosporium* spp.

(A total of 100 spores were counted in a depression slide in 10 different fields with three replicates)

Conc. (per cent)	<i>H.</i> <i>oryzae</i> virulent	<i>H.</i> <i>oryzae</i> avirulent	<i>H.</i> <i>hawaii-</i> <i>ense</i>	<i>H.</i> <i>turri-</i> <i>cum</i>	<i>H.</i> <i>gibbero-</i> <i>sporium</i>
1	100	100	100	100	100
10	100	100	100	100	100
25	100	100	0	34	69
50	0	0	0	0	0
100	0	0	0	0	0
Control	100	100	100	100	100



FIG. 1. Malformation of germ tubes of *Helminthosporium oryzae* by inhibitor in rice leaves.

Khan *et al.*<sup>2</sup> also reported the presence of inhibitors in rice against viruses and the inhibitor was extracted in cold water. The inhibitor extracted in acetone appears to be different, as it contained three fractions ( $R_f$ : 0.74, 0.58, 0.42) when separated on thin layer plates using Silica gel G, developing in butanol-acetic acid-water (3:1:1 v/v). All the three spots were eluted in minimal quantity of water and assayed for their inhibitory acti-

vity. The spot with an  $R_f$  of 0.58 exhibited the maximum toxicity. Colour reaction with diazotized sulphanilic acid and ferric chloride reagent suggested it to be a phenol. The inhibitor was also isolated from other rice varieties like CO. 13 and Co. 29.

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1. Mahadevan, A., *Phytopathol. Z.*, 1968 (In press).
2. Khan, R. P., Allen, T. C. Jr. and Zaimeyer, W. J., *Phytopathology*, 1960, 50, 847.

## EFFECT OF NAPHTHALENEACETIC ACID ON PEDICEL THICKNESS OF GRAPES

### ABSTRACT

Trial experiments showed that pre-harvest application of 100 ppm  $\alpha$ -NAA significantly increased the pedicel thickness in *Anab-E-Shahi* and *Pandhari Sahebi* grapes. In the case of *Anab-E-Shahi*, earlier sprayed bunches had pedicels of greater thickness than in the later sprayed bunches. In *Pandhari Sahebi*, however, even spraying as late as fortnight before harvest resulted in highest degree of thickness. Pre-harvest application of  $\alpha$ -NAA improved berry adherence also.

THICKENED pedicels have been reported to result in firm attachment of berries in the grape bunches. Weaver<sup>1</sup> reported that in the case of *Black Corinth* grapes, both girdling as well as 4-CPA applied singly or in combination increased the pedicel thickness resulting in better adherence of berries. Gibberellic acid is also capable of increasing pedicel thickness.<sup>2</sup> Alpha-naphthaleneacetic acid ( $\alpha$ -NAA) has been mainly used to thin flower clusters in grapes.<sup>3-5</sup> There is however, a report that pre-harvest application of NAA improves berry adherence also.<sup>6</sup> The recent work in India also confirmed that 100 ppm NAA reduces post-harvest berry drop in *Bangalore Blue* grapes.<sup>7</sup> With a view to find

out the effect of NAA on pedicel thickness and attachment of berries, a trial was undertaken.

#### EXPERIMENTAL

Two varieties, namely, *Anab-E-Shahi* and *Pandhari Sahebi* were used for the study. The experiment on the former variety was carried out in the vineyard of the Agricultural College, Dharwar, while that on the latter in the vineyard of a local grape grower during January-March, 1968.

In each variety, the bunches of uniform size, shape and maturity were selected at random and tagged. These bunches were sprayed with 100 ppm aqueous solution of  $\alpha$ -NAA containing 0.5% Tween-20 as wetting agent. The *Anab-E-Shahi* bunches received the spray at two stages of development: the first lot received about two and half months after pruning, when the berries were of the size of the groundnut kernel and the second lot, about a month prior to harvest. The *Pandhari Sahebi* bunches received the spray about a fortnight before harvest.

After harvest, ten bunches were taken from each lot for recording observations. The measurements of pedicel thickness was made with the help of slide calipers at the attachment end. About 6-7 measurements were made in each bunch and totally about 70 observations were recorded for each treatment for statistical analysis. The data are presented in Table I.

of the size of the groundnut kernel, whereas it was 32% in the lots which received the spray at a later stage. This shows that the influence of NAA is controlled by the time of application. In *Pandhari Sahebi*, however, even the late spray resulted in thickness of 75% over control. The berries in the treated lots were more firmly attached than in the case of untreated lots. The pedicels were however slightly brittle in the treated lots.

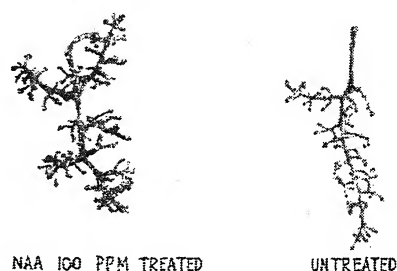


FIG. 1. Photograph showing the thickened pedicels of *Pandhari Sahebi* cluster.

Besides the use in thinning, root induction and weed control, there are no reports of the use of  $\alpha$ -NAA to increase pedicel thickness.<sup>8</sup> The present study showed that the NAA is also capable of increasing the pedicel thickness like 4-CPA or GA, although its effect varies with the variety and time of application.

TABLE I  
Mean pedicel thickness

Sl. No	Treatment	<i>Anab-E-Shahi</i>		<i>Pandhari Sahebi</i>	
		Pedicel thickness (mm.)	% increase over control	Pedicel thickness (mm.)	% increase over control
I	$\alpha$ -NAA 100 ppm sprayed:				
	(I) 2½ months after pruning	3.9	56	..	..
	(II) 1 month before harvest	3.3	32	..	..
II	$\alpha$ -NAA 100 ppm sprayed a fortnight before harvest	..	..	4.2	75
III	Control (no treatment)	2.5	..	2.4	..
L.S.D. at 1%	..	0.21	..	0.50	..

**Results and Discussion.**—There was significant increase in the pedicel thickness in all the treated lots while there was no effect on berry size. In *Anab-E-Shahi* grapes, the percentage of increase of pedicel thickness was 56% over control, in the lots which received the spray at an earlier stage when the berries were

Further trials are however necessary to find out the optimum concentration and time of application for different varieties.

The authors are grateful to Mr. Farooqui, Deputy Mayor, Hubli, for extending the facilities and co-operation for work on *Pandhari Sahebi* variety in his vineyard,

University of Agricultural Sciences,  
M. MADALGATTI RAO.  
U. G. NALVADI.  
Bangalore, May 23, 1968.

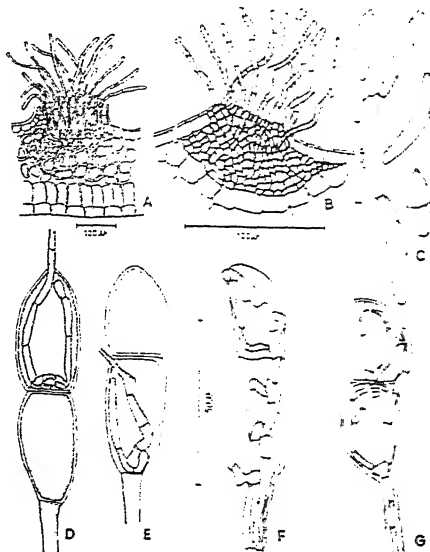
1. Weaver, R. J., *Proc. Am. Soc. Hort. Sci.*, 1953, **61**, 135.
2. Winkler, A. J., *General Viticulture*, Univ. Calif. Press, Berkeley and Los Angeles, 1962.
3. Weaver, R. J., *Proc. Am. Soc. Hort. Sci.*, 1954, **63**, 194.
4. Samish, R. M. and Lavee, S., *Klavin*, 1958, **8**, 273.
5. Singh, D. P., *Sci. & Cult.*, 1959, **24**, 384.
6. Lavee, S., *Vitis*, 1959, **2**, 34.
7. Narasimham, P., Madalgatti Rao, M., Nagaraja, N. and Anandaswamy, B., *J. Food Sci. & Technology*, 1967, **4** (4), 162.
8. Weaver, R. J., *Calif. Agric. Expt. Stat. Bull.*, 1936, No. 752.

### CLADOSPORIUM: A NEW MYCOPARASITE ON RUST

AN undetermined species of *Cladosporium* (Deuteromycetes) was observed by the writer to parasitize the rust on *Polygonum chinense* L. incited by *Puccinia solmsii* P. Henn. in the forest area of Coorg, Mysore State, during the wet season (June-July) 1967. The rust pustules were covered over with the conidial fungus which exhibited itself in the form of circular light green, slightly raised, powdery, smooth colonies. The infection was exclusively confined to the rust pustules on the lower sides of the leaves, being absent from other parts of the lamina.

Sections through the infected pustules revealed that the mycelium of the mould fungus had penetrated deep into the pustules ramifying between the teliospores resulting in partial or complete disintegration of the telial sori (Fig. A). In advanced stages, the telial sori are completely replaced by the stroma of the mould fungus which starts sporulation with the production of thin, olive green, flexuous conidiophore bearing one- to two-celled olive green conidia in chains characteristic of the form-genus (Figs. B and C). A large majority of the two-celled teliospores were found to be plasmolysed as a result of the attack by the mycoparasite, which was observed to enter both cells of the spores and even piercing the long pedicels. Infection of the teliospores is generally achieved through the germ pores rarely by means of infection peg (Figs. D, E, G). The infection may also start from the basal stroma, the parasitic hyphae piercing the pedicel and travelling upwards into the two cells and emerging out from the germ pores (Fig. F). On entering

the cells of the teliospores, the intracellular hyphae attach themselves firmly to the inner wall producing multicellular knob-like structures, which probably act as haustoria (Fig. A). Plasmolysis follows resulting in the complete collapse and disintegration of the rust spores and pustule in the process. It was noted that the teliospores obtained from the infected pustules lose their viability and failed to germinate.



FIGS. A-G. Fig. A. T.S. of *Polygonum chinense* leaf with telium affected by hyperparasite. Fig. B. T.S. showing the sub-epidermal stroma of hyperparasite with conidiophores. Fig. C. Conidiophore and conidia. Figs. D-E. Infection through the germ pores. Fig. F. Infection through the pedicel. Fig. G. Direct penetration of the teliospore.

Since the rust material collected by the writer showed exclusively telial stage, the question as to whether the hyphomycetous mycoparasite was capable of parasitizing uredial and other spore forms of the rust fungus cannot be answered at present.

The writer is grateful to Prof. M. N. Kamat for his deep interest and guidance.

Maharashtra Association B. A. ULLASA.  
for the Cultivation of Science,  
Poona-4 (India), October 18, 1967.

### EFFECTS OF ATP AND EDTA ON CLEAVAGE OF *LIMNAEA* EMBRYOS

THAT ATP should play a role in the energetics of cleavage is quite expected in view of its well-known property, namely, providing the energy supply for biological endergonic pro-

cesses. Nevertheless, the results of experiments on the effects of ATP on developing eggs are contradictory. Brachet<sup>1</sup> and Wolpert<sup>2</sup> gave a short summary of such attempts. Wolpert<sup>2</sup> reported that sea-urchin eggs placed in ATP ( $4 \times 10^{-2}$  M) ten minutes before cleavage would develop in a delayed, abnormal way or would be arrested altogether but later he<sup>2</sup> could not confirm this result and suggested that it was in artefact. In spite of this, the train of reasoning started by the above authors remains interesting especially in connection with the analogy of furrow formation and muscle contraction. We have now examined the effects of ATP on *Limnæa* embryos and, interestingly, we have evidence for arrestation of cleavage by ATP in this material.

*Limnæa* eggs and embryos were collected from the underside of aquatic leaves in the local pond or from earthen vessels in the laboratory where also eggs are laid if leaves are provided. One part of the egg mass was kept as the control and the other part was treated in ATP and then put back to water. By means of such experiments we have established that ATP (100  $\gamma$ /c.c.) permits cleavage but higher concentrations (1000  $\gamma$ /c.c. and 500  $\gamma$ /c.c.) arrest cleavage irreversibly. Some batches of eggs are arrested within half-an-hour of treatment but others require as long as one hour. Uncleaved eggs treated for one hour do not cleave at all. The ATP-arrested eggs do not show any signs of decay and degeneration that usually follow death, till two or three days later.

The inhibitory action is less in later stages of development. For example, treated trochopheres, when they do not succumb to the toxic action and degenerate altogether, are not arrested, though growth rate is subnormal.

Eggs were also treated with 0.5 c.c. apyrase (activity 2.7 units/c.c.) in Tris buffer medium. These eggs stop cleaving but the inhibition is reversible if treatment is not too long.

ATP-arrested eggs (uncleaved, 2-cell, 4-cell) were treated with apyrase for varying periods and some were left in the solution but none cleaved any further.

The result with apyrase shows that it can pass through the capsule and penetrate the embryonic cells where it exerts its effect, presumably by destroying the natural ATP content of the egg. This method may perhaps be employed to investigate the biosynthesis of ATP in developing eggs. It is also clear that arrestation of cleavage is not due to the for-

mation of a protein-ATP complex at the cell surface of such a nature that apyrase can attack the ATP. If the contractile fibre theory be correct, ATP has of course been split and the result certainly does not contradict the theory.

ATP has however a chelating action and Falk<sup>4</sup> offered a startling suggestion that the contraction of muscle cell by ATP is also due to chelation. We therefore compared the action of ATP with that of EDTA, a well-known chelating agent. EDTA (1500  $\gamma$ /c.c.) treatment for 1 hour stops cleavage. A longer treatment is necessary at 750  $\gamma$ /c.c. Some of the uncleaved, EDTA-treated eggs later underwent an alteration of shape (i.e., from spherical to dumbell) which was a clear indication of the attempt at cleavage though none succeeded in accomplishing it. Treated at 2-cell stage, some eggs may attain an "incomplete" division into 4 cells.

We are grateful to the Sigma Chemical Company for a gift of apyrase.

Unit of Embryology, R. L. BRAHMACHARY.  
Indian Statistical Inst., T. K. BASU.  
Calcutta-35, K. P. BANERJI.  
May 18, 1968.

1. Brachet, J., *The Biochemistry of Development* Pergamon Press, 1960, p. 87.
2. Wolpert, L., *Intern. Rev. Cytol.*, 1960, **10**, 207.
3. —, *Nature*, 1958, **181**, 716.
4. Falk, G., *Science*, 1956, **123**, 632.

#### THERMORESPONSE OF *PORTULACA* *OLERACEA* SEEDS

*P. oleracea* is a widely distributed annual of tropical and certain temperate regions.<sup>1</sup> In tropics it survives almost throughout the year, whereas in temperate regions it occurs as summer annual.<sup>2</sup> This species is considered to be one of the 12 most vigorous colonising species.<sup>3</sup> The present studies are concerned with the effect of temperature on germination of seeds of *P. oleracea* (broad leaf variety).

Seeds were collected in the month of April and stored in glass-stoppered bottles at room temperature. Germination tests were carried out in Petri dishes containing 100 seeds between 2 moist filter papers. Three or four replicates were used for each treatment.

It is evident from Fig. 1 that the seeds can germinate well (73–94%) over a wide range of temperature (10–40°). However, the rate of germination is significantly increased with the rise of temperature up to 40° C., beyond



which at 50° C. seeds do not germinate. At 30° or 40° C. germination starts within 24 hours, the peak is obtained within 3 days and the process is completed within 6 days. Germination starts after 2-3 days at 20° C., the peak is obtained after 4-5 days and the process is completed within 13-16 days. On the other hand, germination is delayed for 6-7 days at 10° C., reaching the peak and completion within 8-10 and 19-20 days respectively. Thus, high temperature is clearly favourable for the germination of seeds of *P. oleracea*.

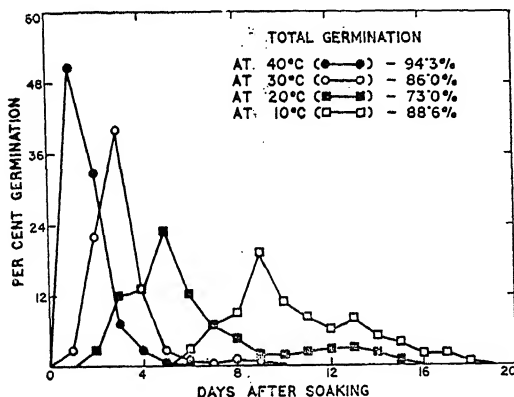


FIG. 1. Thermoresponse of *Pertulaca oleracea* Seed.

Tolerance for high temperature was evaluated by placing soaked seeds in an oven at 50° C. and after various intervals of time transferring them to 40° C. for germination. Table I shows that short 50° C. exposures (2-4 hours) have no effect on germination percentage at 40° C. But long exposures (1-5 days) delay the start of germination by one or two days, extend the germination period up to 9 days, and decrease the total germination percentage.

TABLE I  
Effect of different durations of 50° C. exposures on percentage germination at 40° C.

Duration of exposure	Per cent germination
0 hour (control at 40° C.)	94.3±2.0
2 hours	94.6±1.7
4 hours	94.3±2.3
1 day	86.0±3.2
3 days	76.6±2.9
5 days	20.3±4.1

Mean±standard deviation.

Cold tolerance was studied by exposing the seeds (previously soaked at 20° C. for 24 hours)

to sub-freezing temperature (-15° C.) and then allowing them to germinate at 30° and 40° C. It is evident (Table II) that 1 day cold exposure does not have appreciable effect on germination. However, the cold treatment changes the optimum germination temperature from 40° to 30° C. Such a response, whose mechanism is not clear, has been reported in *Betula lenta*.<sup>4</sup>

TABLE II  
Effect of different durations of sub-freezing temperature (-15° C.) exposure on percentage germination

Duration of exposure day (s)	Percent germination	
	30° C.	40° C.
1	73.2±3.1	21.3±1.9
5	58.6±5.0	22.0±3.3
0 (control at 30° C.)	86.6±2.5	..
0 (control at 40° C.)	..	94.0±4.5

Mean±standard deviation.

In another experiment seeds, stored at 10, 25 and 40° C. for 50 days (since collection), were germinated at different temperatures (20-40° C.). It was noticed that within this period even large difference in storage temperature does not alter germinability.

Levitt<sup>5</sup> has reported that seeds of many species are killed even by very short exposures to extreme temperatures. However, in this respect, *P. oleracea* not only shows great tolerance towards extreme temperatures but also germinates at a wide range of temperatures. Thus, the wide ecological amplitude of this species appears to be due to hardness of its seeds, which enable it to survive in diverse habitats.

The author is grateful to Professor R. Misra and Dr. K. C. Misra for guidance. This research has been financed in part by the P.L. 480 grant of the U.S.D.A.

Department of Botany,  
Banaras Hindu University,  
Varanasi-5, May 14, 1968.

K. P. SINGH.

1. Standley, P. C. and Steyermark, J. A., *Fieldiana Botany*, 1938, 24.
2. Went, F. W., *Chronica Botanica*, 1957.
3. Allard, R. W., In *The Genetics of Colonizing Species*, Ed.: Baker, H. G. and Stebbins, G. L., Academic Press, 1965, p. 49.
4. Meyer, A. M. and Poljakoff Mayber, A., *The Germination of Seeds*, Pergamon Press, 1963.
5. Levitt, J., *The Hardiness of Plants*, Academic Press, Inc., 1956.

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## REVIEWS AND NOTICES OF BOOKS

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**Advances in Nuclear Physics.** Edited by Michel Baranger and Erich Vogt. (Vol. 1). (Plenum Press, New York), 1968. Pp. xiv + 416. Price not given.

This new series of review papers charts the field of nuclear physics. It contains the present state and flavor of current nuclear physics with a varied selection of views and approaches.

The topics chosen range over a wide field, the emphasis being on the physical aspects of each subject rather than on theoretical treatment or experimental techniques. The present volume includes articles by experts on current major topics in nuclear physics research. This series fills a wide gap in the literature by providing coverage of important material by eminent authorities.

The titles of the chapters contained in this volume are as follows: 1. The Reorientation Effect, by Jorrit de Boer and Jorg Eichler; 2. The Nuclear  $SU_3$  Model, by Malcolm Harvey; 3. The Hartree-Fock Theory of Deformed Light Nuclei, by Georges Ripka; 4. The Statistical Theory of Nuclear Reactions, by Erich Vogt; and 5. Three-Particle Scattering—A Review of Recent Work on the Non-relativistic Theory, by Ian Duck. C. V. R.

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**An Introduction to Masers and Lasers—Their Theory and Applications.** By T. P. Melia. (Chapman and Hall Ltd., 11, New Fetter Lane, London EC. 4), 1968. Pp. xiv + 162. Price 35 sh. net in U.K. only.

One of the outstanding technological developments in recent years is the discovery that electromagnetic radiation can stimulate a substance in a particular energy state to emit radiation and amplify the incident beam. The terms *maser* and *laser* have been used to describe the quantum electronic devices in which this type of amplification process occurs. Both the maser and laser can produce an intense, highly directional, coherent beam of electromagnetic radiation at a precisely defined frequency; thereby offering great challenge and promise in a wide range of applications from space communication to a whole new field of "selective chemistry".

This book starts with a historical passage, followed by an introduction to the notation

used in describing energy states and the selection rules governing transitions between them. The nature of electromagnetic radiation is discussed; then various maser and laser systems and their applications are described. There is also a chapter on the health hazards associated with laser beams.

This book will serve as a comprehensive and elementary text suitable for the science undergraduates and research workers. C. V. R.

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**Carnegie Institution of Washington Year-Book** (Vol. 66) (1530, P Street, North-West Washington-5 D.C.), 1966-67. Cloth, octavo, Pp. xi + 76 + 719, 29 plates, 375 figures. Price \$ 10.00.

The well-known Carnegie Institution of Washington was established early in the century with the object of encouraging, in the broadest and most liberal manner, investigation, research, and discoveries, and the application of knowledge to the improvement of mankind. The Year-Books of the Carnegie Institution are indispensable additions to science libraries everywhere. The 66th volume contains the Report of President Caryl P. Haskins and detail reports on the investigations undertaken during the year 1966-67 in the seven departments of the Institution.

In the Department of Plant Biology, in continuation of the observation reported last year on the inhibition of photosynthetic rates of higher plants by atmospheric oxygen, this year's work reports some unexpected results on accelerated growth of plants under reduced oxygen environment. In experiments with beans (*Phaseolus vulgaris*) and monkey flowers (*Mimulus cardinalis*) it was found that reducing the amount of oxygen in the air surrounding the plants accelerates their growth. The average oxygen content of the atmosphere is 21%. In the above experiments the oxygen content of the air around the tops of the plants was reduced to either 5% or 2.5%. The roots were given air of normal oxygen content. Bean seedlings placed in the 2.5% oxygen environment for six days grew 2.1 times as rapidly as they did in normal air. Monkey flowers placed in a 5% oxygen environment showed a growth increase of 90% over the normal. In contrast, corn (*Zea mays*) whose

photosynthetic  $\text{CO}_2$  uptake is unaffected by  $\text{O}_2$  concentration in the range 0-21%, failed to show any significant growth increase under the same conditions. These results open a new field of inquiry into basic differences that have evolved in the photosynthetic mechanism of higher plants.

In the Geophysical Laboratory of the Institution the study of pyroxenes continues to be the major interest. The significance of research on pyroxenes has been enhanced by a growing interest in the chemistry of the earth's mantle (the region between the Mohorovicic discontinuity and the core), in which pyroxenes are known to be a major constituent. They are also commonly encountered in the earth's crust. They have varied chemical compositions and textures resulting from different physical conditions of formation such as temperature, pressure and oxygen fugacity. A quantitative study of equilibria among this group of minerals will help understanding complex petrogenetic history. The classic methods of experimental petrology have been supplemented by a powerful tool—the electron microprobe. Results of investigations are described in detail in the Year-Book.

The Mount Wilson and Palomar Observatories report a new observation on the structure of the Galactic centre. The central region of our Galaxy, seen from our position (far out toward the edge), is heavily obscured by clouds of dust and gas that are concentrated near the plane of the spiral system. In visible light it has been impossible to penetrate these clouds and to discern anything of the structure of the central region. But in longer wavelengths this region is far more transparent, and some years ago a strong radio source, *Sagittarius A*, was detected in the general direction of the centre. Recently it was discovered that the Galactic centre is an emitter of far infrared radiation. In the work during the year, the general infrared radiating centre has been mapped, and it shows a main source of radiation about 10 pc in diameter which agrees in position and size with the radio source *Sagittarius A*.

What is likely to be a subject of interest to evolutionists is the racemization of amino-acids in Fossil Shells. It is known that biological substances differ in optical properties. They may be optically inactive, dextrorotatory (D-form), levorotatory (L-form), or racemized (equal amounts of L and D). Most amino-acids are optically active, and one of the great

biochemical puzzles is why the proteins of all living forms consist principally of L-amino-acids. Results of study during the year of the optical configuration of the amino-acids in Recent and fossil *Mercenaria* shells show the following: (1) Recent—almost entirely L-form. (2) Upper Pleistocene (60,000 years)—partly racemized. (3) Upper Miocene (10 million years)—L and D evenly divided, i.e., completely racemized. Further, it has been observed that fossil shells contain no isoleucine, but contain alloisoleucine, nearly all in D-form. From these findings the conclusion drawn is that primitive ocean contained a racemic mixture of amino-acids. The mystery of how the L-form became the preferred protein form still remains. If some unknown process produced a slight preponderance of either the D-form or the L-form, racemization would restore the equilibrium. On the other hand, once a route to the selective extraction of the L-form was assumed, the L-form supplies could be replenished by racemization from the D-form as the L-form was used up.

The Genetics Research Unit reports experiments leading to some significant advances on the structure and function of phage DNA's, and on the states of a gene locus in maize.

The Department of Terrestrial Magnetism engaged in diverse problems in the general areas of Geophysics, Astrophysics, and Biophysics, gives in detail the progress achieved in problems connected, among others, with earthquake seismology, optical and radio astronomy, and repeated nucleotide sequences.

The increase in price of the present Year-Book to \$10.00 from that of the previous Year-Books (\$1.50) is to be noted. A. S. G.

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**The Cultivation of Parasites *in vitro*.** By Angela E. R. Taylor and J. R. Baker. (Blackwell Scientific Publications, 5 Alfred Street, Oxford, England), Pp. 377. Price 70 sh.

Advances in parasitology are closely connected with the development of suitable methods of cultivating parasites. The book under review will be a most useful laboratory handbook for students and research workers in parasitology. It gives full practical details of methods of the growing of animal parasites *in vitro* which have proved successful and stood laboratory tests.

The book is in three parts. Part 1 deals with the cultivation of protozoa under chapter heads: Trypanosomatidae, Sporozoa, Flagellates

and Ciliates, and Amœbæ. Part 2 deals with the cultivation of helminths under Trematoda, Cestoda, Nematoda parasitic in animals, and Acanthocephala. Part 3 is an appendix giving details of general techniques of *in vitro* culture and of the preparation of media. A. S. G.

**Immunity to Parasites.** Edited by Angela E. R. Taylor. (Blackwell Scientific Publications, 5 Alfred Street, Oxford, England), Pp. 118. Price 37 sh. 6d.

This is a collection of 8 papers presented at the sixth symposium of the British Society for Parasitology on *Immunity to Parasites*, held in London on 17th November 1967. The papers deal with the general principles of immunity and various aspects of immunity in diseases caused by protozoa and helminths.

A. S. G.

## ANNOUNCEMENTS

### Award of Research Degrees

Andhra University has awarded the Ph.D. degree to the following for subject noted against each: Shri B. Subrahmanyam (Physics); Shri V. Seshagiri Rao (Nuclear Physics); Shri P. Y. Subba Rao (Chemistry); Shri A. Satyanarayana Murty (Zoology).

Utkal University has awarded the Ph.D. degree in Chemistry to Shri Pradipta Kumar Josthi.

Sri. Venkateswara University has awarded the Ph.D. degree in Geology to Shri A. Kripinidhi.

### Nuclear Physics and Solid State Physics Symposium

The Nuclear Physics and Solid State Physics Symposium organised by the Physics Committee of the Department of Atomic Energy, will be held at the Indian Institute of Technology, Powai, Bombay, on December 28, 29, 30 and 31, 1968. The last date for sending the abstracts for the contributed papers is November 1, 1968. Nuclear Physics abstracts should be sent to Dr. M. N. Visweswariah, Van de Graaff Laboratory, Nuclear Physics Division, Bhabha Atomic Research Centre, Trombay, Bombay-74 AS and the Solid State Physics Abstracts should be sent to Dr. N. S. Satya Murthy, Nuclear Physics Division, 2nd Floor, B Block, Modular Laboratories, Bhabha Atomic Research Centre, Trombay, Bombay-74 AS.

### Symposium on the Living Resources of the Seas Around India

The symposium has been fixed for the 3rd to 5th December, 1968 in Cochin. Detailed programme will be intimated in due course to all who register as participants.

Intimation of participation at the symposium should be sent to the Director, Central Marine Fisheries Research Institute, Marine Fisheries P.O., Mandapam Camp (Madras State), at least a fortnight in advance.

### Books Received

*Introduction to Business Statistics.* By G. Hadley. (Holden-Day, Inc., 500, Sansome Street, San Francisco), 1968. Pp. x + 463. Price \$10.75.

*The Elementary Functions.* By C. F. Fleenor, M. E. Shanks, C. F. Brumfiel. (Addison-Wesley Pub. Co., Inc., London W. 1), 1968. Pp. ix + 293. Price 65 sh.

*Study Problems in Organic Chemistry.* By D. W. Hutchinson. (Addison-Wesley Pub. Co., 11, Hills Place, London W. 1), 1967. Pp. xiii + 144. Price 26 sh.

*Molecular Scattering of Light.* By Immanuel L. Fabelinskii. (Translated from Russian by R. T. Beyer) (Plenum Press, 227 West, 17 Street, New York), 1968. Pp. xxvii + 622. Price not given.

*Annual Review of Pharmacology* (Vol. 8). By H. W. Elliott, W. C. Cutting and R. H. Dreisbach. (Annual Reviews, Inc., 4139 El Camino Way Palo Alto, California 94306), 1968. Pp. vii + 594. Price \$8.50 in U.S.A.; \$9.00 elsewhere.

*Oestrogenic Constituents of Forage Plants.* By E. M. Bickoff. (Commonwealth Agricultural Bureaux, Farnham), 1968. Pp. 39. Price 10 sh.

*Proceedings of the Research Seminar—Coal—A Petrographic Approach.* (Department of Geology, Nagpur University, Amravati Road, Nagpur), 1968. Pp. 81. Price not given.

*British Medical Bulletin* (Vol. 24, No. 2, May 1968)—*Structure and Function of Membranes.* (The Medical Department, The British Council, 15 Davies St., London, W. 1), 1968. Pp. 99-186. Price £2.

*Introduction to Thermodynamics of Irreversible Processes.* By I. Prigogine. (John Wiley and Sons, Inc., Pub., New York), 1968. Pp. xv + 147. Price \$5.95.

# METRE AND DECAMETRE SOLAR RADIO BURSTS RECORDED DURING JULY 6-11, 1968

S. K. ALURKAR, R. V. BHONSLE AND S. S. DEGAONKAR

*Physical Research Laboratory, Ahmedabad*

THE period from July 6-11, 1968 has been very active with regard to solar radio emission in the metre and decametre wavelength region. We report here solar radio bursts and sudden cosmic noise absorption (SCNA) observed by a solar spectroscope (40-240 MHz) and a 21.3 MHz riometer at Ahmedabad. There were nearly 45 radio bursts of varying intensity and spectral types, out of which we report here some 27 bursts which have been recorded simultaneously on the solar spectroscope and the riometer.

Figures 1(a) and 1(b) show a complex radio event which occurred on July 6, 1968. (a) shows the SCNA on 21.3 MHz with two

Bursts B are continuum type IV which lasted for about 8 minutes. Figure 2 shows three ionograms at 09, 10 and 11 hr. UT on 6-7-1968. It can be seen that there is complete short wave fade-out at 10 hr. UT while at 09 and 11 hr. records appear normal.

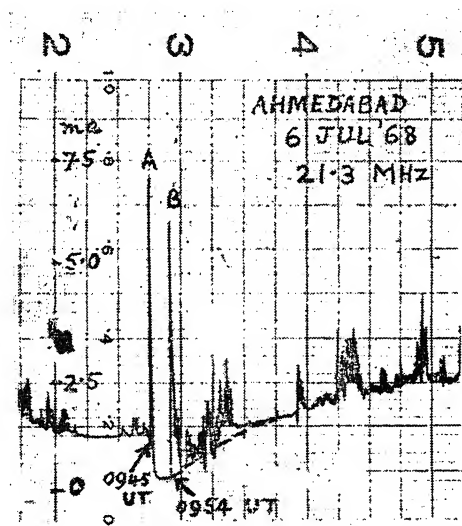


FIG. 1 (a). Cosmic radio noise record at 21.3 MHz showing SCNA and solar radio noise bursts on 6-7-1968.

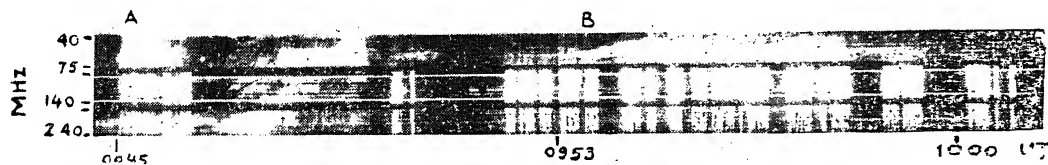


FIG. 1 (b). A dynamic spectrum of the radio burst obtained at the same time by solar radio spectroscope.

bursts denoted by A and B. (b) shows the dynamic spectrum of the radio burst. Burst A is seen to be fast drift type III followed within 2 minutes by a slow drift type II

burst. (b) shows at the same time a strong radio burst which has exceeded the chart range.

In Table I we have listed the 27 bursts giving solar radio flux intensities in watts

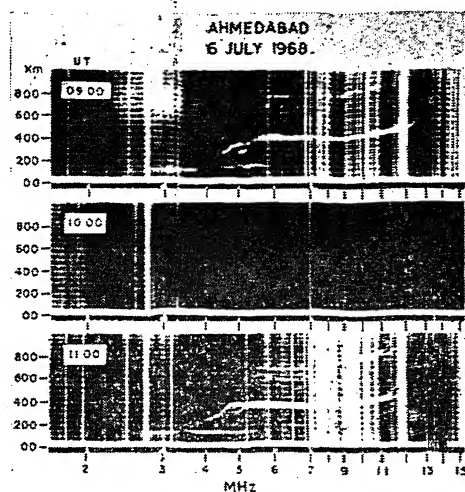


FIG. 2. Ionograms showing the short wave fade-out during the solar event and the normal records about one hour before and after the event.

We have shown in Fig. 3 one more example of a very strong radio burst which occurred on July 9, 1968. The starting frequency of the type III-type V burst is about 140 MHz. The burst has become much stronger and longer in duration at the lower frequency end. The 21.3 MHz riometer record

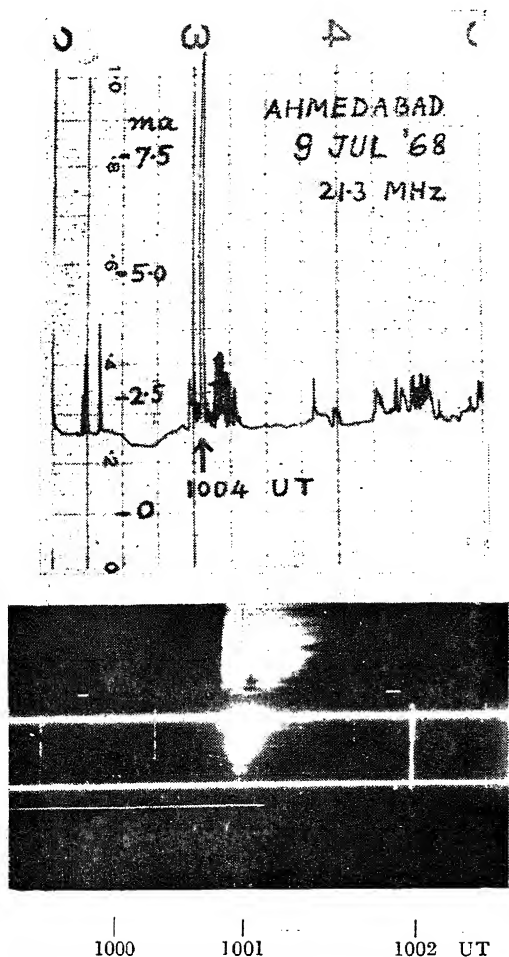


FIG. 3. Another example of a solar radio noise burst on the cosmic radio noise at 21.3 MHz on 9-7-1968 and corresponding type III-type V burst on solar radio spectroscope.

metre<sup>2</sup> (Hz)<sup>-1</sup> as calculated from the riometer data and the spectral types as observed on the solar radio spectroscope. In the last column, we have given the approximate starting frequencies of the bursts as obtained from the spectrograms. The burst intensities have been corrected for the solar zenith angle and the flux density of source is calculated by<sup>1</sup>

$$S = \frac{2kT_s \cdot \Omega_s}{\lambda^2}$$

where

$k$  = the Boltzmann constant =  $1.38 \times 10^{-23}$  joules/degree K.  $T_s$  = the apparent disk temperature of the sun.  $\Omega_s$  = the mean solid angle in steradian subtended by the photosphere of the sun at the antenna.  $\lambda$  = the operating wavelength = 14.1 metres.

TABLE I

Date	Time UT	Equivalent Antenna Temp. °K. $\times 10^4$ at 21.3 MHz.	Power flux $\pi m^{-2}$ (Hz) <sup>-1</sup> $\times 10^{-11}$ at 21.3 MHz	Type of burst	Starting frequency of burst MHz
6-7-1968	0945	5.5	2.6	III	240
	0953	4.4	2.1	IV	..
	0759	2.0	0.9	III	140
7-7-1968	0931	0.8	0.4	III	140
	0651-53	3.7	1.7	III	130
	0730	3.8	1.8	III-V	125
	0736	3.8	1.8	III-V	130
8-7-1968	0742	4.9	2.3	III-V	170
	0614	3.9	1.8	III	135
	0912	1.2	0.6	III	125
	1001	7.4	3.5	III-V	130
9-7-1968	0415	2.0	0.9	III	100
	0615	1.1	0.5	III	100
	0618	2.2	1.0	III	75
	0621-22	2.6	1.2	III	75
	0644	3.4	1.6	III	75
	0648	2.0	0.9	III	75
	0727	3.3	1.6	III-V	220
	0745	3.5	1.7	III-V	240
	0909	1.2	0.6	III	140
	0933	1.3	0.6	III	200
11-7-1968	0454-59	1.2	0.5	III	75
			group		
	0508-09	0.7	0.3	III	75
	0548	0.3	1.3	III-V	130
	0553	0.2	0.9	III	130
	0903	0.1	0.7	III-V	140
	1134	3.6	1.7	III-V	120

Now the equivalent antenna temperature  $T_A$  is given by

$$T_A = \frac{\Omega_s}{\Omega_A} \cdot T_s$$

where

$\Omega_A$  = the antenna beamwidth = 0.3 steradian in our case of a broadside collinear array having  $4 \times 4$  half-wave dipoles,  $\Omega_s = 6.8 \times 10^{-5}$  steradians, and  $T_s = 5800$  IR, where  $I$  = the noise diode current in amperes,  $R$  = the load of the noise diode in ohms which is 1000 ohms in our riometer. The post detector integration time constant for increasing noise signal is of the order of one minute. Therefore the peak intensities of the radio bursts calculated here give the lower limit to the flux values.

It can be seen from Table I that the flux density of the solar bursts is of the order of  $10^{-21}$  watts/m<sup>2</sup>(Hz)<sup>-1</sup> which has varied within a factor between 0.5 and 3.5. As compared with the quiet sun flux at 21.0 MHz, this intensity is about 1000 times more powerful.<sup>2</sup> A detailed study of these events is in progress and will be reported elsewhere.

ACKNOWLEDGEMENT

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Bansidhar and N. S. Nirman for help in maintaining the equipments.

1. Kundu, M. R., *Solar Radio Astronomy*, Interscience Publishers, New York, 1965, p. 63.
2. Smerd, S. F., *Annals of the IGY*, 1964a, p. 34.

SYNTHESIS OF BENZOCHROMENES AND RELATED COMPOUNDS

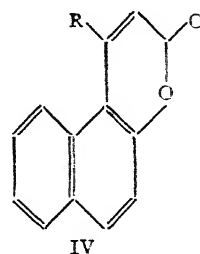
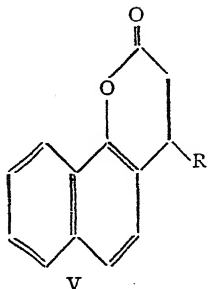
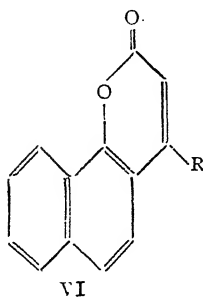
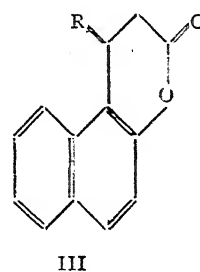
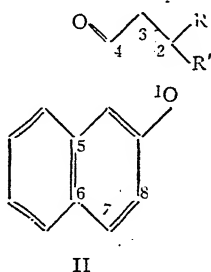
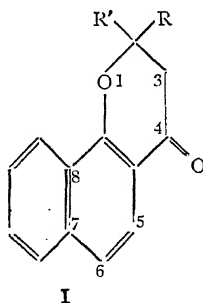
Part I. 5:6 and 7:8 Benzochromanones and Benzocoumarins

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**D**URING our study of the naturally occurring fungicides belonging to the class of benzochromenes, methods of syntheses of 5:6 and 7:8 benzochromanones were critically examined. Among several methods,<sup>1-8</sup> the condensation of  $\alpha$ - and  $\beta$ -naphthols with substituted crotonic acids offers a facile method. Such a condensation between polyhydric phenols and crotonic acids was already effected using  $\text{SbCl}_3$ ,  $\text{ZnCl}_2$  or  $\text{SnCl}_2$ ,<sup>3,4</sup>  $\text{P}_2\text{O}_5$ ,<sup>5</sup> polyphosphoric acid<sup>6</sup> or  $\text{AlCl}_3$ .<sup>7</sup> Alternatively, the phenolic esters of crotonic acids were subjected

to the current investigation,  $\alpha$ - and  $\beta$ -naphthols were condensed with  $\beta$ : $\beta$ -dimethyl acrylic acid and crotonic acid in presence of  $\text{SbCl}_3$ ,  $\text{ZnCl}_2$  and polyphosphoric acid to secure 7:8 and 5:6 benzochromanones (I, II). The optimum conditions with  $\text{SbCl}_3$  and  $\text{ZnCl}_2$  were found to be heating at 140–50° for 1–2 hr., while with polyphosphoric acid, heating on a water-bath for 1 hr. would be sufficient. The latter reagent caused exclusive formation of benzochromanones (I, II) in good yields (upto 70%). But,  $\text{SbCl}_3$  and  $\text{ZnCl}_2$  furnished



to Fries migration using  $\text{AlCl}_3$ <sup>7</sup> or  $\text{HF}$ <sup>8</sup> to yield the chromanones.

them only in low yields (12–30%). The results are summarised in Table I.

TABLE I\*

Sl. No.	Compound	M.P. or B.P.	I.R.-CO $\nu$ in $\text{cm}^{-1}$	Mol. Form.	Required		Found	
					C	H	C	H
A. 7 : 8-Benzo series :								
1	2 : 2-dimethyl chromanone <sup>7</sup>	136-40° 0.8 mm.	1680	C <sub>15</sub> H <sub>14</sub> O <sub>2</sub>	79.62	6.24	79.29	5.90
2	2 : 4-d.n.p. <sup>7</sup>	281-82°	..	C <sub>21</sub> H <sub>18</sub> O <sub>5</sub> N <sub>1</sub>	62.07	4.46	62.37	4.64
	2-methyl chromanone	164-68° 0.7 mm.	1680	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	79.23	5.70	78.94	5.86
3	2 : 4-d.n.p.	288-85°	..	C <sub>20</sub> H <sub>16</sub> O <sub>5</sub> N <sub>1</sub>	61.22	4.11	61.10	4.12
	3 : 4-dihydro 4 phenyl couma- rin	110-11°	1770	C <sub>19</sub> H <sub>14</sub> O <sub>2</sub>	83.19	5.14	82.81	5.37
4	4-phenyl coumarin	125-26°	1730	C <sub>19</sub> H <sub>12</sub> O <sub>2</sub>	83.81	4.44	83.83	4.03
5	3 : 4-dihydro 4-( <i>p</i> -methoxy) phenyl coumarin	127-28°	1770	C <sub>20</sub> H <sub>16</sub> O <sub>3</sub>	79.83	5.30	78.68	5.25
6	4-( <i>p</i> -methoxy) phenyl couma- rin	160°	1730	C <sub>20</sub> H <sub>14</sub> O <sub>3</sub>	79.46	4.67	79.07	4.89
B. 5 : 6-Benzoseries :								
1	2 : 2-dimethyl chromanone <sup>7†</sup>	160-64°/ 1.5 mm.	1670	C <sub>15</sub> H <sub>14</sub> O <sub>2</sub>	79.62	6.24	79.14	6.34
2	2 : 4-d.n.p. <sup>7</sup>	257-58°	..	C <sub>21</sub> H <sub>18</sub> O <sub>5</sub> N <sub>1</sub>	62.07	4.46	61.84	4.31
	2-methyl chromanone <sup>8</sup>	75-76°	1675	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	79.23	5.70	79.07	5.91
3	2 : 4-d.n.p. <sup>8</sup>	260-62°	..	C <sub>20</sub> H <sub>16</sub> O <sub>5</sub> N <sub>1</sub>	61.22	4.11	60.98	3.85
	3 : 4-dihydro 4-methyl couma- rin	153-54°	1770	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	79.23	5.70	78.89	5.82
4	4-methyl coumarin <sup>9</sup>	180-81°	1730	C <sub>14</sub> H <sub>10</sub> O <sub>2</sub>	79.58	4.79	79.53	5.14
5	3 : 4-dihydro 4-phenyl couma- rin <sup>11</sup>	114-15°	1790	C <sub>19</sub> H <sub>14</sub> O <sub>2</sub>	83.17	5.14	82.89	5.22
6	4-phenyl coumarin	157-58°	1735	C <sub>19</sub> H <sub>12</sub> O <sub>2</sub>	83.81	4.44	84.09	4.58
7	3 : 4-dihydro 4-( <i>p</i> -methoxy) phenyl coumarin	116°	1760	C <sub>20</sub> H <sub>16</sub> O <sub>3</sub>	78.93	5.20	79.02	5.49
8	4-( <i>p</i> -methoxy) phenyl couma- rin	115-16°	1730	C <sub>20</sub> H <sub>14</sub> O <sub>3</sub>	79.46	4.67	79.21	4.44

\* All the compounds described above are purified by column chromatography over alumina or silica gel and then subjected to vacuum distillation or crystallisation from suitable solvents.

† Livingstone *et al.*<sup>4</sup> recorded the m.p. 81° for 5 : 6-benzo 2 : 2-dimethyl chromanone (II, R=R'=Me) obtained by Friedel and Craft's method. But, in our hands the benzochromanone was obtained as colourless liquid B.P. 160-64°/1.5 mm. whose 2 : 4-d.n.p. agreed with the m.p. recorded by Livingstone *et al.* To resolve this difference, their synthesis was repeated with scrupulous adherence to their experimental conditions. Only a liquid benzochromanone was again secured which gave a 2 : 4-d.n.p. identical with that obtained earlier using polyphosphoric acid or  $\text{SbCl}_5$ .

In the condensation between  $\beta$ -naphthol and crotonic acid the 2-methyl 5 : 6-benzochromanone (II, R=H, R'=Me) was accompanied by a minor product (III, R=Me) when  $\text{SbCl}_3$  or  $\text{ZnCl}_2$  was used, while polyphosphoric acid gave exclusively the benzochromanone (II, R=H, R'=Me). The minor compound (III, R=Me; m.p. 153-54°;  $\nu$  1770  $\text{cm}^{-1}$ ) exhibits green fluorescence in concentrated  $\text{H}_2\text{SO}_4$  and dissolves in 10% aqueous NaOH with bluish-violet fluorescence. It was proved to be a 3 : 4-dihydro coumarin which on dehydrogenation with 30% Pd-C gave 4-methyl 5 : 6-benzocoumarin (IV, R=Me) identical with an authentic sample prepared following the method of Seshadri *et al.*<sup>9</sup>

This formation of 4-methyl 5 : 6-benzo 3 : 4-dihydro coumarin (III, R=Me) led us to

investigate the condensation between  $\alpha$ - and  $\beta$ -naphthols with cinnamic acid and its *p*-methoxy derivative. Miyano and Mitsui<sup>3</sup> recorded the formation of the corresponding coumarin with phloroglucinol and cinnamic acid; but with resorcinol only a cinnamoyl ester was obtained. Buu-Hoi *et al.*<sup>10</sup> prepared 3 : 4-dihydro 7 : 8-benzo 4-phenyl coumarin (V, R= $\text{C}_6\text{H}_5$ ) by condensing  $\alpha$ -naphthol and cinnamic acid in presence of concentrated  $\text{H}_2\text{SO}_4$  by refluxing in tetralin solution. In the present study,  $\alpha$ - and  $\beta$ -naphthols were condensed with cinnamic acid and its *p*-methoxy derivative using  $\text{SbCl}_3$ ,  $\text{ZnCl}_2$  at 140-50° and  $\text{HOAc-H}_2\text{SO}_4$  (1 : 1) at refluxing temperature. In all the three reagents, the 3 : 4-dihydro-4-phenyl benzocoumarins (III, V R= $\text{C}_6\text{H}_5$ ) were formed exclusively. These could be dehydrogenated with 30% Pd-C to



yield the 4-phenyl benzocoumarins (IV, VI  $R = C_6H_5$ ). With *p*-methoxy cinnamic acid, however,  $\beta$ -naphthol yielded a coumarin (IV,  $R = C_6H_4OMe$ ) (lactone  $C=O$ , 1730  $cm^{-1}$ , m.p. 115°, brilliant fluorescence in concentrated  $H_2SO_4$ ) instead of a dihydro coumarin (III,  $R = C_6H_4OMe$ ). This point was confirmed by hydrogenating it and securing the 5:6-benzo 4-*p*-methoxyphenyl 3:4-dihydro coumarin (III,  $R = C_6H_4OMe$ ) (lactone  $C=O$ , 1760  $cm^{-1}$ , m.p. 116°). The mixed m.p. (90–94°) of these two compounds (III and IV,  $R = C_6H_4OMe$ ) was also depressed. It is rather difficult to explain this difference in the condensation between  $\alpha$ - and  $\beta$ -naphthols and *p*-methoxy cinnamic acid.

Thus, cinnamic acids yield coumarins while substituted crotonic acids yield a mixture of chromanones and coumarins with both phenols and naphthols. This variation in their reactivity may be explained on the basis of resonance in these molecules where the  $\beta$ -carbon is comparatively less reactive in cinnamic acids compared to the  $\beta$ -carbon in crotonic acids.

#### EXPERIMENTAL

A typical procedure is given below for the synthesis of benzochromanones.

**7:8-Benzo 2:2-Dimethyl Chromanone.**—(I,  $R = R' = Me$ ) (a) Using  $SbCl_3$ .—A mixture of  $\alpha$ -naphthol (7.2 g., 2 moles),  $\beta$ : $\beta$ -dimethyl acrylic acid (5 g., 2 moles) and freshly distilled  $SbCl_3$  (5.7 g., 1 mole) was heated in an oil-bath at 140–50° for 1 hr. The mixture was cooled and extracted with ether. The ether extract was washed with dilute HCl (1:1), water, cold 5% aqueous NaOH and finally with water. It was then dried and evaporated. The brown liquid was distilled under vacuum at 136–40°/0.8 mm. to get the chromanone as pale yellow viscous liquid (yield 3.45 g.).

(b) The above synthesis was repeated using  $ZnCl_2$  instead of  $SbCl_3$  (yield 2.1 g.).

(c) Using Polyphosphoric Acid.—Polyphosphoric acid was prepared by mixing  $P_2O_5$  (8 parts by weight, 40 g.) with syrupy ortho phosphoric acid (85%, 5 parts by volume, 25 ml.) and stirred at 85° for half-an-hour before use.

A mixture of  $\alpha$ -naphthol (7.2 g., 1 mole)  $\beta$ : $\beta$ -dimethyl acrylic acid (5 g., 1 mole) and the above phosphoric acid was heated at 95° for 1 hr. on a water-bath. Working up the reaction mixture as above gave the chromanone (4.6 g.).

**5:6-Benzo 3:4-Dihydro 4-Phenyl Coumarin.**—(III,  $R = C_6H_5$ ) (a) Using concentrated  $H_2SO_4$ .—A mixture of  $\beta$ -naphthol (12 g.), cinnamic acid (12.4 g.), glacial acetic acid (35 ml.) and concentrated  $H_2SO_4$  (15 ml.) was refluxed for 1 hr. The mixture was poured into ice-cold water and working up in the usual way, gave the benzo coumarin which crystallised from ethanol (charcoal) as colourless prisms (5.6 g.) m.p. 114–15°.

(b) With  $SbCl_3$  or  $ZnCl_2$ , experimental conditions are similar to those followed for benzochromanones.

One of us (C. S. K.) expresses his grateful thanks to the Council of Scientific and Industrial Research, for a Junior Research Fellowship.

1. Kostanecki, St. V. and Foremsdorff, G., *Ber.*, 1902, **35**, 859.
2. Bhullar, A. S. and Venkataraman, K., *J. Chem. Soc.*, 1931, p. 1165.
3. Miyano, M. and Matsui, M., *Bull. Chem. Soc. Japan*, 1958, **31**, 397.
4. Anjaneyulu, A. S. R., Rao, M. V. R. K., Sastry, G. P., Row, L. R. and Rao, G. S. R. S., *J. Sci. Ind. Res.*, 1961, **20 B**, 69.
5. Knollpfeiffer, F. and Schultze, H., *Ber.*, 1924, **57**, 206.
6. Hurd, C. D. and Hayao, S., *J. Amer. Chem. Soc.*, 1954, **76**, 5065; Loudon, J. D. and Razdon, R. K., *J. Chem. Soc.*, 1954, p. 4299.
7. Livingstone, R. and Watson, R. B., *J. Chem. Soc.*, 1957, p. 1509; Livingstone, R., Miller, D. and Watson, R. B., *Ibid.*, 1958, p. 2422.
8. Dann, O., Volz, G. and Huber, O., *Ann.*, 1954, **587**, 16.
9. Murty, K. S., Rao, P. S. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1937, **6 A**, 316.
10. Bau-Hoi, N. G. P., I.e Bihan, H., Binon, F. and Maleyran, P., *J. Org. Chem.*, 1952, **67**, 1122.
11. Keelsch, C. F., *J. Amer. Chem. Soc.*, 1936, **58**, 1326.

# ON THE OCCURRENCE OF *HYPSELEPHAS HYSUDRICUS* IN THE PLEISTOCENE DEPOSITS OF TIRUNELVELI, MADRAS STATE\*

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AND

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THE evolutionary history of proboscideans has always been of great interest to Vertebrate Palaeontologists. As pointed out by Osborn<sup>1</sup> they rank next to man in biological importance and far surpass the mechanically inferior man in demonstration of all the main principles of biomechanical aristogenesis and alloimetry. The material under description, a partial skull was recovered from Ayyanidipu (8° 45' : 78° 7') 6.5 kilometres west, on the Tuticorin-Palayamcottah road. A small patch of late Tertiary sediments of probable Pliocene-Pleistocene age occurs in a series of detached outcrops in the coastal belt of Tirunelveli-Tuticorin. A brief note on the present find was published by Easterson<sup>2</sup> without assigning the material to any specific group. Therefore, a detailed description of the skull has been attempted by the authors.

A few well sections near Sayamalai (9° 5' : 77° 4'), Tirunelveli District, have also yielded a few vertebrate fossils of Pleistocene age (Tripathi<sup>3</sup>). Critical field studies by one of us (Prasad) of a number of well sections reveal that the tuffaceous kankar bands and the compact sandstones containing the vertebrate fossils are barely five to six metres thick and overlie the Archæans directly. The occurrence of *Hypselephas hysudricus* in this part of the region is of considerable interest as it throws some new light on the distribution of the group Elephantinae during the Pleistocene times. This is the first record of *Hypselephas* from the Pleistocene beds other than the Siwaliks of Punjab Himalayas.

Genus *HYPSELEPHAS* OSBORN 1936

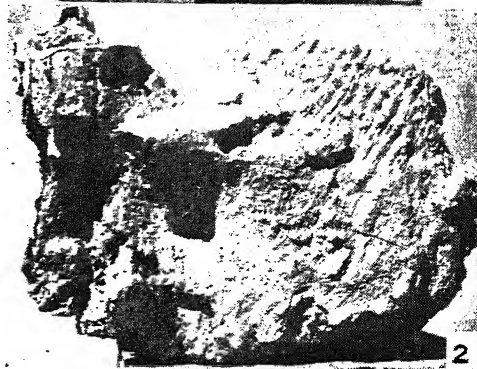
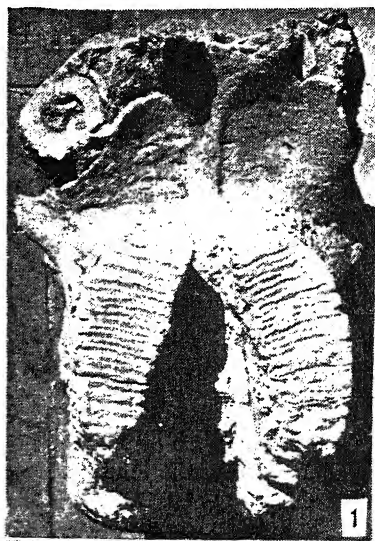
Genotypic species:

*Hypselephas hysudricus* Falconer, 1845

(Figs. 1 and 2)

The original material described by Falconer<sup>4</sup> from the Siwaliks is from the Lower Pleistocene. He considered *Elephas hysudricus* as

related to *E. indicus*. Adams<sup>1</sup> believed them to be ancestral to *Loxodonta* and *Elephas*. On the other hand, Pohlig<sup>1</sup> considered them as ancestral to *Elephas namadicus*. However, Osborn<sup>1</sup> regarded them as more closely related to *E. indicus* although by no means ancestral. Forty-three specimens are known from the Siwalik (Lower Pleistocene) beds of Punjab.



FIGS. 1-2. *Hypselephas hysudricus* Falc.  
Fig. 1. Palatal view,  $\times 1/5$ , approx. Fig. 2. Side view,  $\times 1/5$ , approx.

\* Published with the kind permission of the Director-General, Geological Survey of India.

**Description and Comparison.**—The cranium of *Hypselephas hysudricus* differs from those of *Loxodonta* but the frontal profile somewhat resembles *E. indicus*. The cranium as a whole is far less bathycephalic. As pointed out by Osborn<sup>1</sup> the deep concavity of the forehead is exaggerated by the overlying fronto-occipital crest used for the attachment of great muscles of head, neck and proboscis. The low position of the orbits in *Hypselephas hysudricus* is a specific distinction. Ridge

Formula :  $\frac{M\ 3\ 17-}{17-19}$

The relatively low-crowned grinding teeth in the upper and lower jaws with maximum elevation of superior and inferior third molars are correlated with two important characters of the cranium and jaws. The mandibles must have been shallow, primitive, exhibiting a strong rostrum. The crowns of the superior molars are rather low, and therefore, the orbits are placed immediately above the roots. These characters have been emphasised by Osborn<sup>1</sup> while comparing the skull of *Hypselephas* with those of *Elephas* and *Loxodonta*. The cranium under description apparently belongs to an adult female with contracted premaxillaries as in *Elephas indicus*. The molar ridge plates which are seventeen in number are highly worn indicating that the owner was an adult, and a female of the species, characters deciphered on the basis of the tusk sockets.

#### Superior Third Molar

Length : 230 mm. Width : 90.0 mm.

It displays 17 plus ridge plates of which the anterior five are completely worn. The relatively flat and backwardly sloping occiput is characterised by small tusks (width : 110 mm.) with less rugose orbits. The palatal view (Fig. 1) indicates the extreme brachycephaly of the cranium. This contrasts strongly with the elongate and less widely expanded palate of *Archidiskodon planifrons*. The relatively close crowding of the tusks makes the space between the third molar and occipital condyles extremely short. The palatal aspect

indicates the presence of a large downwardly directed tusks with extreme brachycephaly of occipital region and extreme fore-and-aft shortening of cranium by approximation of incisive tusks to condyles, characters considered by Osborn for specific distinction. On the palatal aspect, the palatine ledge of maxillary, the palatines, the anterior palatine foramina (canals) and part of the maxilla with tusk sockets can be made out. The molars are however broken.

The Pliocene ancestors of the recent Indian elephants have not been recovered so far in the fossil state. The *Hypselephas hysudricus* found below the Boulder Conglomerates in the Upper Siwaliks of India shows some resemblance to *Elephas indicus* in so far as the cranial characters are concerned. However, no resemblance appears to exist in the molar pattern of the grinding teeth. Apparently, *Hypselephas hysudricus* was a primitive elephant with an elevated cranium. The premaxillaries were relatively narrow or laterally compressed. The orbits were large and depressed near maxillary rostrum unlike *Loxodonta* or *Elephas*. The superior tusks (Fig. 2) were straight incurved divergent to some extent at the base with no inferior tusks. In so far as the grinding teeth are concerned, the molars were low crowned, long and narrow. The ridge plates seventeen in number, convexo-concave with plicated enamels are rather characteristic of this species. *Hypselephas hysudricus* as pointed out by Osborn<sup>1</sup> had a modernised cranium with relatively primitive condition of the molars. Further collections and study may reveal the true relationships of these forms with the modern elephants. The specimen, bearing the registered number SRV 1/30, is preserved in the collections of the Geological Survey of India, Southern Region, Hyderabad.

1. Osborn, H. F., *Proboscidea*, 1942, 2.
2. Easterson, D. C. V., *Curr. Sci.*, 1966, 35 (24), 622.
3. Tripathi, C., *Rec. Geol. Surv. Ind.*, 1964, 93.
4. Falconer, H., *Paleontological Memoirs*, 1846, 1847.

## SOURCE OF THE METAL IN THE LEAD COINS OF THE KSHATRAPA PERIOD

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**F**ORTY-FIVE lead coins were recovered in stratified association with sherds of Roman amphoræ, Red Polished Ware, Painted Ware and crude Black and Red Ware, all of which belong to the early centuries of the Christian era, in an excavation of the early historic site at Nagara (70° 38' 33" E, 20° 41' 15" N) in Cambay Taluka, Kaira District, Gujarat State. The excavation was carried out by the Department of Archaeology and Ancient History of the Faculty of Arts, M.S. University of Baroda, during the field seasons of 1963-64 and 1964-65, under the direction of Professor R. N. Mehta.<sup>1</sup>

Lead coins in similar stratigraphic association have been recovered from Vadnagar,<sup>2</sup> Devnimori<sup>3</sup> and Shamalaji.<sup>4</sup> But as the coins carried only motifs without any legend or date, it was not possible to ascribe them to any particular dynasty of rulers.

On chemical treatment for removal of corrosion incrustation, several among the Nagara coins revealed bull motif on the obverse, mountain and moon motifs on the reverse. A few of them also revealed a human figure with dots on the obverse, lion or mountain and moon motifs on reverse or Vajra symbol on the obverse, horse and wheel motifs on the reverse.

One of these coins was particularly interesting because it revealed a standing bull on the obverse, mountain and moon motifs on the reverse and below them there was the date of issue of the coin which was deciphered by the excavator as the year 285 in Saka era, that is, 363 A.D. On the basis of this date and the motifs which the coins carry it has now been possible to tentatively ascribe these coins to the Kshatrapa dynasty,<sup>5</sup> which ruled parts of Western India from the beginning of 2nd century A.D. to the end of 4th Century A.D.

These coins were found in circular, rectangular and square shapes. They were all thickly encrusted with corrosion compounds. After chemical treatment for reduction of corrosion incrustation, most of them were found to be highly worn out. Their weight varied from 6.136 gm. to 1.263 gm. Their thickness was not uniform.

As these lead coins were widely circulated in Western India and now firmly dated, it was considered desirable to investigate the source of the lead metal. An analytical study carried out on the Kshatrapa silver coins had indicated that the silver metal was not extracted from the indigenous source but was probably imported.<sup>6</sup> It was, therefore, interesting to know whether the lead metal of the coins was extracted from the locally available source or imported. It was also considered desirable to learn the quality of the metal, whether it was pure or deliberately alloyed.

For the purpose of analytical study sound core of the metal was selected from two coins after their chemical treatment for corrosion incrustation. The coins were partially worn, but both clearly carried extant remains of the Kshatrapa motifs of bull on the obverse, mountain and moon symbols on the reverse.

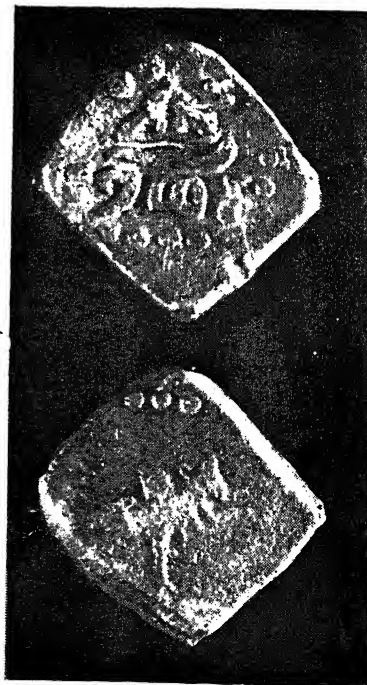


FIG. 1. Obverse and reverse of the date bearing lead coin excavated from Nagara, × 2.

*Source of the Lead Metal.*—The principal ore of lead is galena or lead sulphide,  $PbS$ . Lead deposits are also found as anglesite,  $PbSO_4$ , lanarkite,  $PbO$ ,  $PbSO_4$  and cerussite  $PbCO_3$ . Galena in small quantities, sometimes accompanied by cerussite, has been found at many places in India. Larger deposits of the ore are observed at Dhadka in Bihar, Metri in Mysore, Riase and Kistewar in Kashmir and the Aravalli region in Rajasthan.<sup>7</sup> Among these deposits, the Rajasthan deposits are the largest. They are located at several places on the Aravallies. One of these is at Zawar, 15 miles south of Udaipur. This deposit, spread over a large area, comprising Mochia Mangra, Baror Mangra and Zawar Mala hills, is also observed to have been worked for centuries as there are vast lead metallurgical slag heaps in the area.<sup>8</sup> The ore here mainly constitutes argentiferous galena, associated with zinc blende.

The Aravalli region lead deposits were the closest to the Kshatrapa kingdom. Probably the ore deposits were within the limits of the kingdom. In view of the fact that the Zawar deposits were worked for centuries, it was interesting to investigate whether it was possible to link the Kshatrapa period lead coins with the Aravalli region galena deposits.

All ancient metal objects contain a large number of elements, some of them in minute traces, as impurities. These impurities are chance inclusions in the metal. They are drawn into the composition of the metal from the raw material from which the metal was extracted. A comparative study of impurity patterns in the objects and the likely ore deposits is helpful in determining the geographic origin of the metal of the objects.

Therefore a spectrometric study was carried out in samples cut from the coins and the ore deposit, obtained from Zawar, to determine their respective impurity patterns. The study revealed the data as shown in Table I.

almost the same. The coins contain all the impurities present in the ore except calcium and beryllium in coin I and calcium in coin II. Further, the coins do not contain additional impurities which the ore in itself does not contain. Therefore, it is possible to observe that the metal of the coins was probably extracted from the Zawar galena deposits. From this it is also possible to observe that the Indian lead metallurgical industry was at least sixteen centuries old, probably two centuries older.

*Quality of the Metal.*—Lead is one of the softest and heaviest of common metals. It can be cut by knife. It can be rolled and extruded. It is, therefore, not a suitable coinage metal. Coins need a stronger and harder metal. The only endearing quality of lead for coinage is its high resistance towards corrosion. Strength and hardness of lead can be improved by alloying with antimony, arsenic or copper. It was, therefore, interesting to investigate whether this metal was used in minting the coins as extracted or alloyed.

A quantitative chemical analysis in the two coins revealed the following percentage composition.

TABLE II

Specimen	Composition							
	Pb	Zn	Mg	Al	Cu	Sb	As	Un-determined
Coin I	97.40	1.26	0.26	0.38	tr	tr	tr	0.70
" II	97.21	1.18	0.42	0.29	"	"	"	0.90

The percentage composition of the coins indicate that the lead metal was used as extracted. It was not alloyed to improve its hardness and strength.

TABLE I

Specimen	Impurity pattern																								
	Zn	Ag	Au	Cu	Fe	Mg	Ca	Al	Mn	Cr	Co	Ni	Hg	Bi	Cd	As	Sb	Sn	Be	V	Ru	Pt	Mo	Ir	U
Galena ore ..	+	+	+	+	+	+	+	+	+	-	-	-	-	-	+	+	+	+	+	+	+	+	-	-	-
Coin I ..	+	+	+	+	+	+	-	+	+	-	-	-	-	-	+	+	+	+	-	+	+	+	-	-	-
„ II ..	+	+	+	+	+	+	-	+	+	-	-	-	-	-	+	+	+	+	+	+	+	+	-	-	-

Table I shows that the pattern of impurities in the ore sample and the coins is

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and making valuable suggestions; to the National Mineral Development Corporation, for kindly supplying the galena ore sample from Zawar and to Dr. M. M. Patel and Sri P. D. Patel for helping in the spectrometric analysis.

1. Mehta, R. N., *Nagara*, M. S. University Archaeology, Series No. 10, 1968, p. 116.
2. Subba Rao, B. and Mehta, R. N., "Excavation at Vadnagar," *Journal of the M.S. University of Baroda*, 1955, 1, 34.

3. Mehta, R. N. and Chowdhary, S. N., *Excavation at Devnimori*, 1966, p. 104.
4. —, "A rare lead coin from Shamalaji," *Journal of the Numismatic Society of India*, 1966, 28, Part I, 10.
5. —, *Nagara*, *op. cit.*
6. Hegde, K. T. M., "Chemical and spectrometric studies in Kshatrapa silver coins," *Journal of the Numismatic Society of India*, 1967, 29, Part I, 63.
7. Brown, J. C. and Dey, A. K., *India's Mineral Wealth*, Oxford University Press, 1955, p. 156.
8. *The Wealth of India*, Part V, Council of Scientific and Industrial Research, 1960, p. 193.

## MORPHOLOGY OF THE "SQUAMELLAE" IN THE LIGHT OF THEIR ONTOGENY

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**S**QUAMELLAE (or colleters), which are a characteristic feature of the Apocynaceae, Asclepiadaceae and others,<sup>8-12</sup> have been variously interpreted in the literature, viz., as hairs,<sup>12</sup> stipules,<sup>2-6-8-11</sup> ligules<sup>9</sup> and receptacular outgrowths.<sup>8-9</sup> But all these workers have drawn conclusions from the mature structure of the squamellae and their organographic position rather than on their ontogeny. The authors present here their findings on the ontogeny of the squamellae in *Allamanda cathartica* L., and *Tabernaemontana divaricata* (L.) R. Br. (Apocynaceae), because of the conclusive nature of the evidence they provide relating to their morphology.

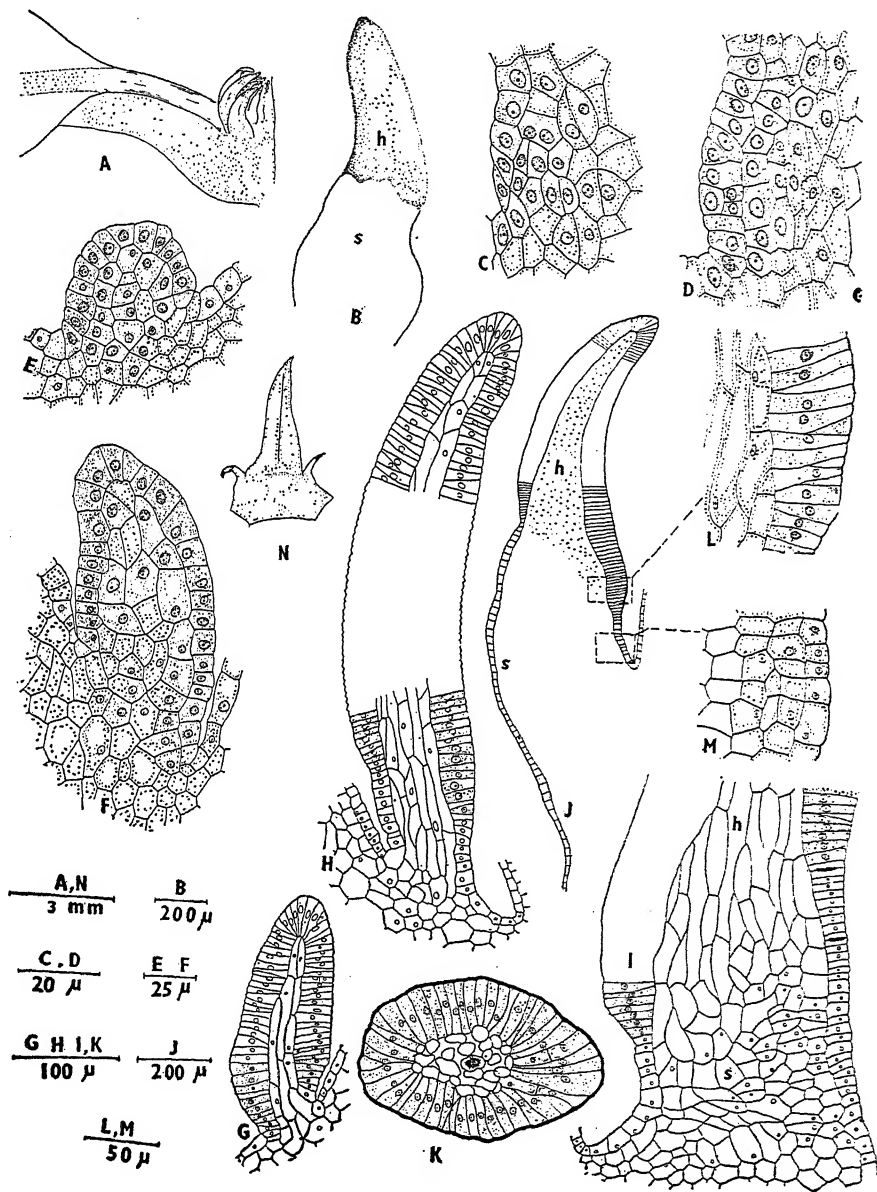
**Allamanda cathartica:** The squamellae occur only at the leaf-base towards its adaxial side (Fig. A). Each leaf bears 10 to 13 squamellae arranged in a transverse row which in young buds cover the shoot apex; none occur on the sepals unlike in some other species of the family,<sup>1-8-9</sup> though one or two are borne on the distal margin of the bracts and bracteoles (Fig. N). While young, the squamellae secrete a sticky substance which coats the shoot apex all over, probably providing it protection. The substance is brown-yellow and transparent, insoluble in water, alcohol, acetone, benzene and petroleum ether, but liquefies at high temperature; hence it is considered to be a high polymer resin. The squamellae are 1.5 mm. long and 0.3 mm. broad, differentiated into a stalk and a head (Fig. B). The stalk is nearly cylindrical, but abaxially more curved (Fig. J), while the head, obliquely placed on

the stalk, is somewhat flattened parallel to the leaf surface as shown by its transection (Fig. K). In longisections the epidermal cells of the stalk appear isodiametrical to elongated and those of the ground tissue mostly isodiametrical (Fig. M), whereas the head consists of palisade-like epidermis of densely stained cells and ground tissue of mostly elongated elements (Fig. L). The stalk is green and photosynthetic, whereas the head is brown-coloured, and glandular in nature. The details of the ontogeny are as follows:—

Squamellae develop from primordia consisting of protoderm and the subtending subprotoderm elements appearing at the base of the leaf on its adaxial face when it is about 500  $\mu$  long (Fig. C). At this stage the leaf consists of mere protoderm, ground meristem and procambium indicating the phase of its cell multiplication rather than differentiation of any tissues. The primordial cells appear distinctive from the adjacent ones due to their relatively dense cytoplasm (Fig. C). The protoderm cells divide anticlinally, with occasional oblique and periclinal divisions, while the subprotoderm cells in various planes, particularly in transverse ones (Figs. C and D). Consequently, the primordium becomes elongated and grows upward, parallel to the leaf on which it is borne (Fig. E). The epidermal as well as ground elements of the squamellae at this stage remain nearly isodiametrical (Figs. E and F). Later, while the ground cells elongate axially, the epidermal cells divide through rapid anticlines (occasionally in

oblique and periclinal planes) to cope with the increasing length of the ground tissue (Fig. G). With this, the differentiation phase of the head comes to an end, for it now possesses a core of elongated cells and a palisade-like

densely stained epidermis as seen in mature condition (compare Fig. G with Fig. L). Meanwhile, the stalk also begins differentiation. The first change noticed consists in the occurrence of rapid anticlines in the basal cell



FIGS. A-N. *Allamanda cathartica*. Fig. A. Leaf-base with the squamellæ. Fig. B. A single squamella. Figs. C-H. Developmental stages from l.s. leaf. Fig. I. Stalk of a developing squamella showing subdivisions in the hitherto axially elongated ground cells. Fig. J. L.S. mature squamella from l.s. leaf (Diagrammatically represented). Fig. K. T.S. head of mature squamella. Fig. L. A sector of the head of mature squamella shown in Fig. J., enlarged. Fig. M. A sector of the stalk of mature squamella J, enlarged. Fig. N. A bract with two squamellæ on its margin. (s = stalk; h = head.)

tiers of the protoderm (Fig. G), but since the cells thus produced soon start elongation and vacuolation, they appear narrower and longer than the overlying palisade form epidermis of the head (Fig. H). The ground cells of the corresponding basal region which were so far longer than broad (Fig. H), now divide through anticlines and other planes and become nearly isodiametrical (Fig. I) as seen in the mature stalk (Fig. M). The squamella later enters the phase of its maturation when all its cells become enlarged. Neither vascular tissue nor laticifers, a characteristic of the other parts of the plant, appear in the squamellæ. Occasional ground cells, however, show sphærocrystals (Fig. K).

*Tabernaemontana divaricata*: Leaves as well as sepals bear the squamellæ adaxially at their base. On the leaf they are numerous and occupy almost the entire basal area, while on the sepal 4 or 5 are situated at its middle about 2 mm. above the base and parallel to each other. No squamellæ occur on the bracts and bracteoles as in *Allamanda cathartica*. The squamellæ of both the leaf and sepals are nearly of the same size being about one-third to half a millimeter in length and half as much or lesser in breadth; unlike in *Allamanda cathartica*, their stalk is quite short or almost absent. As in the above species, they are non-laticiferous and non-vasculated. The squamellæ of the leaf follow the same pattern of development as in *Allamanda cathartica*, except that the stalk is shortly developed, while in the sepals only the head is differentiated.

From the ontogeny as well as other characters it is obvious that the squamellæ, in the two species investigated, cannot be regarded as hairy structures as has been described in the past,<sup>12</sup> since they are derived from a primordium made up of both protoderm and ground elements. That they are stipular in nature<sup>2,9,11</sup> is also not tenable on more than one ground. Unlike the stipules which are derived from the leaf-base as its lateral extensions,<sup>4</sup> the squamellæ are produced from the leaf adaxial surface. The squamellæ also do not develop a marginal meristem as in the stipules.<sup>4</sup> Besides they are borne at the distal margin of the bracts and bracteoles as in *Allamanda cathartica*, a position never occupied by the stipules. Finally, the squamellæ are numerous and adaxially situated at the leaf-base unlike the stipules.

Rao and Ganguli<sup>9</sup> regarded the non-vasculated squamellæ comparable to the ligule. This is equally not suggestive in as much as the origin is from a primordium made up of both protoderm and ground elements unlike that of the ligule which is initiated through periclinal division in the foliar protoderm.<sup>3</sup> Further the ligule represents an appendage of a specific location at the junction of the leaf-sheath and blade in the Gramineæ, whereas the squamellæ may be borne near the base of the leaf and sepals and also at the margin of the bracts and bracteoles. Agarwal's view (See Refs. 8 and 9) that the squamellæ represent receptacular outgrowths is not acceptable for neither do they originate from nor borne by the receptacle.

In view of the peculiar features shown by the squamellæ in their development, structure and organographic distribution, we therefore conclude that they represent emergences of a glandular nature. Regarding the emergence, Ramayya<sup>7</sup> has recently shown that they bear the following essential characters: (1) originate from a primordium consisting of protoderm and subprotoderm elements, (2) in the case of major plant organs consist of the three fundamental tissue systems, epidermis, ground tissue and vascular tissue (the last may be absent) and (3) are borne both by the stem and foliar appendages. It is obvious that squamellæ whether vasculated or non-vasculated conform to the above definition.

#### ACKNOWLEDGEMENTS

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1. Gamble, J. S., *Flora of the Madras Presidency*, 1957, 2, Reprint (B.S.I.).
2. Gluck, H., *Verhandl. d. Natur-his. -Med. Ver. Heidelberg. N.F.*, 1, 1901, 1.
3. Kaufman, P. B., *Phytomorphology*, 1959, 9 (3), 277.
4. Majumdar, G. P., *Proc. Ind. Acad. Sci.*, 1956, 43 B, 9.
5. Metcalfe, C. R. and Chalk, L., *Anatomy of the Dicotyledons*, Clarendon Press, Oxford, 1950, 2, 906.
6. Nygan, P. T., *Ann. Mo. Bot. Gdn.*, 1965, 52 (2), 114.
7. Ramayya, N., *Curr. Sci.*, 1964, 33 (19), 577.
8. Rao, V. S., *Proc. Ind. Acad. Sci.*, 1963, 57 B, 15.
9. — and Arti Ganguli, *J. Ind. Bot. Soc.*, 1963, 42 (3), 419.
10. Woodson, R. E. Jr., *Ann. Mo. Bot. Gdn.*, 1930, 17, 1.
11. — and Moore, J. A., *Bull. Torrey Bot. Cl.*, 1938, 62, 471.
12. Solereder, H., *Systematic Anatomy of the Dicotyledons*, Clarendon Press, Oxford, 1908, 2.



## LETTERS TO THE EDITOR

### MAGNETIC GREY GROUPS

THE introduction of the time reversal operation  $\mathcal{R}$  increases the number of the point groups from 32 to 122. These 122 groups can be broadly divided into two categories: (i) the 32 grey groups in each of which  $\mathcal{R}$  occurs explicitly and (ii) the 90 magnetic symmetry groups including the 32 conventional point groups. Extensive work on the derivation of the magnetic symmetry groups and the study of the physical properties of crystals belonging to the symmetries of these groups has been carried out by several investigators. Not much theoretical work seems to have been done on the derivation of the magnetic variants of the grey groups. In this note it is proposed to describe and enumerate the number of the distinct magnetic variants of the 32 grey groups.

If  $H$  is a subgroup of index 2 of a group  $G$ , then there exists a real non-total symmetric one-dimensional irreducible representation (alternating representation)  $\Gamma_H$  of  $G$  such that  $H$  and  $\Gamma_H$  are in one-to-one correspondence and all the elements of  $G$  which are represented by the character  $+1$  in  $\Gamma_H$  form the subgroup  $H$  (Indenbom,<sup>1</sup> Niggli,<sup>2</sup> Opechowski and Guccione,<sup>3</sup> Bertaut<sup>4</sup> and Krishnamurty and Gopalakrishnamurty<sup>5</sup>). If  $G$  is now taken as a grey group,  $H$  may be coloured or uncoloured. If  $H$  is uncoloured, it will coincide with one of the 32 crystallographic point groups. On the other hand if  $H$  is coloured, it may coincide with one of the 32 grey groups or one of the 58 double coloured magnetic point groups. The authors<sup>5</sup> have established that the non-equivalent alternating representations of a group  $G$  induce the distinct magnetic variants of  $G$ . It is shown, on similar lines, here that there are 64 distinct magnetic variants of the 32 grey groups and they are described below.

The character tables of the 32 double point (grey) groups, which also contain the additional spin representations, have been given by Koster.<sup>6</sup> An alternating representation of a double point group in which the character  $\chi(\mathcal{R})$  of the time reversal operation  $\mathcal{R}$  is  $+1$  has been termed (Tinkham<sup>7</sup>) as a normal single-valued representation and  $\chi(\mathcal{R}) = -1$

is designated as a spin representation. Each one of the non-equivalent normal single-valued representations of a double point group induces a magnetic variant of the group. Thus the 58 non-equivalent normal single-valued representations of the 32 grey groups induce the 58 distinct magnetic variants. These 58 variants can be easily expressed as the direct products of the 58 double coloured magnetic point groups with the grey group consisting of the elements  $E$  and  $\mathcal{R}$ . In addition to these 58 normal single-valued representations, there are 6 spin alternating representations which are present only in the double point groups as indicated below:

$$1(1), \bar{1}(2), 3(1) \text{ and } \bar{3}(2).$$

Thus one obtains a total number of 64 magnetic variants of the grey groups. As one can see easily the total symmetric representation of a double point group induces a magnetic group which cannot be distinguished from the given double point group. In this way the 96 magnetic grey crystal classes can be described and built up. The grey groups can be used to build up paramagnetic or diamagnetic crystals (Bhagavantam<sup>8</sup>). As has been already shown by the authors,<sup>5</sup> the number of independent constants required to describe any physical property for the induced variants of the grey groups can be obtained from the inducing alternating representations.

The authors wish to express their thanks to Prof. T. Venkatarayudu for his kind interest in the problem.

Andhra University, T. S. G. KRISHNAMURTY.  
Waltair, July 2, 1968. P. GOPALAKRISHNAMURTY.

1. Indenbom, V. L., *Soviet Phys. Crystall.*, 1959, **4**, 578.
2. Niggli, A., *Z. Krist.*, 1959, **111**, 288.
3. Opechowski, W. and Guccione, R., *Magnetism*, Academic Press, London, 1965, **2 A**, 105.
4. Bertaut, E. F., *Acta Cryst.*, 1968, **A24**, 217.
5. Krishnamurty, T. S. G. and Gopalakrishnamurty, P., A paper on "Magnetic Symmetry Groups" communicated to *Acta Cryst.*, 1968.
6. Koster, G. F., *Solid State Physics*, Academic Press, London, 1957, **5**, 238.
7. Tinkham, M., *Group Theory and Quantum Mechanics*, McGraw-Hill Book Co., New York, 1964, p. 77.
8. Bhagavantam, S., *Crystal Symmetry and Physical Properties*, Academic Press, London, 1966, p. 53.

# ON THE SIMILARITY OF SURBUR'S AND POLEY'S METHODS OF DETERMINATION OF DIELECTRIC CONSTANT AT MICROWAVE FREQUENCIES

APART from the well-known Von Hippel's<sup>1</sup> method of measuring dielectric constant at microwave frequencies, the other two standard methods for the case of liquids are those described by Surbur<sup>2</sup> and Poley.<sup>3</sup>

This note is to show that though both the latter methods apparently look different, particularly in the terminology used to describe them, basically they are identical. It was thought worthwhile to point out the similarity in the two methods because in literature these methods are tacitly treated as being different from each other.

Experimentally, in both the methods, V.S.W.R. (Voltage Standing Wave Ratio) is measured as a function of the depth of the liquid column, the graph between the two displaying maxima and minima of V.S.W.R. We denote  $\eta_m$  the V.S.W.R. for the  $m$ th maxima (counted as the depth of the liquid column increases) and  $\eta_\infty$  the V.S.W.R. for "infinite liquid column" meaning thereby the practically constant value of V.S.W.R. attained as the liquid column extends beyond some finite length. The guide wavelength  $\lambda_{g1}$  in the liquid column is the spacing between two consecutive minima of V.S.W.R. In Surbur's method the V.S.W.R. is either deduced from the reflection coefficient or can be measured by including a slotted section between direction coupler and liquid cell. In Poley's method, V.S.W.R. is measured directly by using a slotted section.

In Surbur's method a plot is provided between the ratio  $\eta_m/\eta_\infty$  and  $D$ , the dissipation factor, given by

$$D = \frac{\epsilon''}{\epsilon' - \left(\frac{\lambda_v}{\lambda_g}\right)^2}$$

Knowing the experimental values of  $\eta_m$  and  $\eta_\infty$ ,  $D$  is determined. Knowledge of  $D$  and  $\lambda_{g1}$  yields  $\epsilon'$  and  $\epsilon''$  by the following expression given by Surbur,

$$\epsilon' = \left(\frac{\lambda_v}{\lambda_g}\right)^2 + \left(\frac{\lambda_v}{\lambda_{g1}}\right)^2 [1 - \tan^2 (\frac{1}{2} \tan^{-1} D)] \quad (1)$$

$$\epsilon'' = \frac{1}{\pi} \left(\frac{\lambda_v}{\lambda_{g1}}\right)^2 a_d \lambda_d \quad (2a)$$

and

$$a_d \lambda_d = 2\pi \tan (\frac{1}{2} \tan^{-1} D) \quad (2b)$$

$$\epsilon'' = 2 \left(\frac{\lambda_v}{\lambda_{g1}}\right)^2 \tan (\frac{1}{2} \tan^{-1} D) \quad (3)$$

Poley in his method introduces

$$\tan \Delta = \frac{\epsilon''}{\epsilon' - \left(\frac{\lambda_v}{\lambda_g}\right)^2}$$

and provides graphical relations between  $\tan \frac{1}{2} \Delta$  and  $\eta_m/\eta_\infty$  and also  $\tan \frac{1}{2} \Delta$  and  $\eta_m/\eta_n$  (not provided by Surbur). Knowledge of  $\tan \frac{1}{2} \Delta$  and  $\lambda_{g1}$  as before yields  $\epsilon'$  and  $\epsilon''$

$$\epsilon' = \left(\frac{\lambda_v}{\lambda_g}\right)^2 + \left(\frac{\lambda_v}{\lambda_{g1}}\right)^2 [1 - \tan^2 \frac{1}{2} \Delta] \quad (4)$$

$$\epsilon'' = 2 \left(\frac{\lambda_v}{\lambda_{g1}}\right)^2 \tan \frac{1}{2} \Delta \quad (5)$$

and

$$\tan \Delta = \frac{\epsilon''}{\epsilon' - \left(\frac{\lambda_v}{\lambda_g}\right)^2}$$

At this stage, the relation between the above Surbur's and Poley's equations look almost obvious.

We first note that expressions for  $D$  and  $\tan \Delta$  are identical. We have, therefore,

$$\frac{\Delta}{2} = \frac{1}{2} \tan^{-1} D$$

Substituting  $\Delta/2$  for  $\frac{1}{2} \tan^{-1} D$  in Surbur's equations (1) and (3), we get Poley's equations (4) and (5).

Thus we have shown that the methods of Surbur and Poley are identical in terms of experimental procedure and the formulation employed for determining  $\epsilon'$  and  $\epsilon''$ .

National Physical Laboratory, R. S. YADAVA.  
New Delhi-12, D. C. DUBE.  
July 24, 1968. R. PARSHAD.

1. Roberts, S. and Von Hippel, A., *J. Appl. Phys.*, 1946, 17, 610.

2. Surbur, W. H. Jr., *Ibid.*, 1948, 19, 514.

3. Poley, J. Ph., *Appl. Sci. Res.*, 1954-55, 4 B, 337.

## PHOTOELECTRIC CROSS-SECTIONS OF GAMMA-RAYS IN ALLOYS

EXPERIMENTAL studies on photoelectric cross-sections of gamma-rays in alloys can be made (1) by the direct method on the alloys themselves or (2) by determining the cross-sections in individual elements and adding them, assuming the theoretical sum rule. In this paper we report the results on the photoelectric cross-sections in two platinum-rhodium alloys as determined by both the methods.

Utilising a modified narrow beam geometry with as large a solid angle as permissible, and a single crystal scintillation spectrometer, total gamma-ray cross-sections (without coherence) have been determined at gamma energies 84 and 100 keV ( $\text{Tm}^{170}$  and  $\text{Gd}^{153}$  gamma sources were obtained from The Bhabha Atomic Research Centre, Bombay) in Rh, Pt and Pt-Rh alloy I (Pt: 60%, Rh: 40%) and Pt-Rh alloy II (Pt: 80%, Rh: 20%). From these the theoretical incoherent scattering cross-sections evaluated on the basis of Thomas-Fermi model and reported by Brown<sup>2</sup> are subtracted to obtain the photoelectric cross-sections in alloys as well as in elements. In the case of alloys the theoretical incoherent scattering cross-sections are estimated according to the theoretical sum rule. However, as the contribution due to these cross-sections (maximum 9%) to the total cross-sections is small, the error induced in the deduced photoelectric cross-sections by this procedure is negligible. Utilising the photoelectric cross-sections in the individual elements, the cross-sections in the alloys have also been estimated assuming the theoretical sum rule. These cross-sections, along with the theoretical values of Schmickley and Pratt,<sup>1</sup> are given in Table I.

TABLE I

Photoelectric cross-sections of gamma-rays in alloys in barns per atom

Alloy and composition		Energy in keV	
		84	100
Alloy I (Pt: 60%, Rh: 40%)	Expt. I	1118 ± 77	759 ± 36
	Expt. II	1122 ± 78	752 ± 36
	Theo.	1251 ± 25	764 ± 8
Alloy II (Pt: 80%, Rh: 20%)	Expt. I	1552 ± 93	1061 ± 53
	Expt. II	1546 ± 93	1044 ± 52
	Theo.	1756 ± 35	1108 ± 11

Expt. I: Directly measured in alloys. Expt. II: Measured in individual elements (Pt and Rh) and computed assuming the theoretical sum rule. Theo: Theoretical values computed from the reported values of Schmickley and Pratt utilising the theoretical sum rule.

From the excellent agreement observed between the experimental results determined by both the methods it may be concluded that the theoretical sum rule is valid. Also, the agreement between the experimental values and the theoretical values is within the range of errors especially at 100 keV.

In Table II a comparison is made of the theoretical and experimental photoelectric cross-sections in the individual elements at the two gamma energies.

TABLE II

Photoelectric cross-sections of gamma-rays in Rh and Pt in barns per atom

Element		Energy in keV	
		84	100
Rh	Experimental	309 ± 16	199 ± 10
	Theoretical	320 ± 6	197 ± 4
Pt	Experimental	2142 ± 171	1469 ± 74
	Theoretical	2430 ± 49	1540 ± 8

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Waltair, July 13, 1968. J. RAMA RAO.

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- Schmickley, R. D. and Pratt, R. H., *Phys. Rev.*, 1967, 163, 104.
- Brown, W. D., *Bositz Company Report*, D2-125137-1, 1966.

## INFRARED ABSORPTION SPECTRUM OF $\beta$ -BROMOSTYRENE

STYRENE belongs to mono-substituted benzenes which possess an unsaturated double bond in their substituent group. The vibrational spectrum of styrene has been studied in Raman,<sup>1-4</sup> and infrared<sup>5-9</sup> under different conditions by various workers. But there seems to be no data available either on Raman or infrared spectra of  $\beta$ -bromostyrene. We have, therefore, recorded the infrared absorption spectrum of this molecule in the region 690–4000  $\text{cm}^{-1}$  and made vibrational assignments. The spectrum has been recorded in liquid phase on a Perkin-Elmer double beam infrared spectrophotometer (Model 13 U) using a cell of thickness of 0.02 mm. enclosed with NaCl windows. The accuracy of the measurement is 2  $\text{cm}^{-1}$  between 690–1500  $\text{cm}^{-1}$ , 4  $\text{cm}^{-1}$  between 1500–3000  $\text{cm}^{-1}$  and 10  $\text{cm}^{-1}$  above 3000  $\text{cm}^{-1}$ .

Styrene together with  $\beta$ -bromostyrene belongs to  $C_s$  point group. The molecular plane containing all the atoms is the only element of symmetry present in the molecule. An application of group theory shows that the possible vibrations are only of two types: one,  $a'$  symmetric to the molecular plane, and the other,  $a''$  antisymmetric to it. The total number of possible fundamental vibrations are

42 out of which 29 are  $a'$  and 13 are of  $a''$ . All are allowed in infrared and Raman spectra.

The assignments of fundamental frequencies have been made on the basis of comparison with those of similar molecules like ethylene<sup>10</sup> ( $H_2C=CH_2$ ) benzene<sup>11</sup> and styrene.<sup>7</sup> In addition, assistance has also been taken from the assignment of the three isomeric chloro- and bromostyrenes.<sup>12,13</sup>

The assignment of fundamental frequencies of  $\beta$ -bromostyrene is given in Table I.

TABLE I

Infrared absorption spectrum of  $\beta$ -bromostyrene

Infrared (cm. <sup>-1</sup> )	Intensity	Assignment
690	9	$a'$ C—C—C o.p. bending
734	10	$a''$ C—H o.p. bending
770	5	do.
835	3	do.
912	3	do.
		(in CH : CHBr group)
940	10	$a''$ C—H o.p. bending
983	2	do.
1006	2	$a'$ C—C stretching (ring breathing)
1030	3	$a'$ C—H i.p. bending
1071	4	do.
1158	2	do.
1186	4	do.
1221	8	$a'$ C—X stretching
1280	3	$a'$ C—H i.p. bending
1297	2	$a'$ C—H wagging (in CH : CHBr group) (Methylanic wagging frequency)
1323	4	$a'$ C=C stretching
1448	6	$a''$ C—H scissoring mode (CH <sub>2</sub> vib.)
1490	5	$a'$ C=C stretching
1570	5	do.
1600	7	do.
		(ethylanic group frequency)
2800	2	$a'$ C—H stretching (in CH : CHBr group)
3014	6	$a'$ C—H stretching

o. p. = out-of-plane, i. p. = in-plane, X = CH : CHBr group.

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Department of Spectroscopy, K. SINGH,  
Banaras Hindu University, V. B. SINGH,  
Varanasi-5, July 18, 1968.

1. Lespieu and Bourguet, *Bull. Soc. Chim.*, 1930, **47**, 1365.
2. Bourguet, *Compt. rend.*, 1932, **194**, 1736; **195**, 331.
3. Misushima, S. I. et al., *Bull. Chim.*, 1937, **47**, 1365.
4. Roy, N. K., *Indian J. Phys.*, 1954, **28**, 365.
5. Stair, R. and Cobletz, W. W., *J. Res. Natl. Bur. Standards*, 1935, **15**, 295.
6. William, D., *Physics*, 1936, **7**, 399.

7. Pitzer, K. S., Guttman, L. and Westrum, E. F., *J. Am. Chem. Soc.*, 1943, **65**, 803.
8. Barnes, R. B., Gore, R. C., Liddel, U. and Williams, V. Z., *Infrared Spectroscopy*, 1944.
9. American Petroleum Institute Research Project 44, *Catalogue of Infrared Spectral Data*, Serial No. 170.
10. Herzberg, G., *Infrared and Raman Spectra*, D. Van Nostrand Company, Inc., 1945, p. 326.
11. —, *Ibid.*, D. Van Nostrand Company, Inc., 1945, p. 364.
12. Tripathi, G. N. R., *Ph.D. Thesis*, Gorakhpur Univ., 1967.
13. Ansari, B. J., Private communication, Gorakhpur Univ.

## PREPARATION OF $m$ -PHENYLENEDIISOTHIOCYANATE

$m$ -PHENYLENEDIISOTHIOCYANATE is a useful intermediate in the preparation of certain interesting heterocyclic compounds.<sup>1</sup> It also finds applications as an antiseptic, an insecticide, and in some drug preparations. Billeter and Steiner<sup>2</sup> prepared it by the reaction<sup>3</sup> of thiophosgene ( $CSCl_2$ ) on  $m$ -phenylenediamine. Another method, patented in United States, describes its preparation by heating  $m$ -phenylenediisocyanate with phosphorus pentasulphide in an inert solvent. The former method is considered to be the most convenient one, and is generally preferred<sup>1,5</sup> but because of the very high cost of thiophosgene, the method is not of common use. The latter method is also of little importance as it involves the use of an extremely rare chemical,  $m$ -phenylenediisocyanate. There is another method,<sup>6</sup> available for the preparation of the isomeric compound,  $p$ -phenylenediisothiocyanate, involving the reaction of  $p$ -phenylenediamine with carbon disulphide and ammonia, isolating the corresponding bis-dithiocarbamate, treating it with sodium chloroacetate, and finally decomposing the product at pH 7, by zinc chloride. We report here the application of this method, with some modifications, to the preparation of  $m$ -phenylenediisothiocyanate, in fairly high yields.

**Procedure.**—A mixture of 20 g. (0.18 mole) of  $m$ -phenylenediamine, 40.3 g. (32 ml.; 0.53 mole) of carbon disulphide, 63 g. (70 ml.; 3.7 mole) of concd. aq. ammonia (sp. gr. 0.9), and 40 ml. of water, cooled with ice-cold water, was stirred mechanically for 2 hr. at 20–25°C. A thick precipitate of ammonium- $m$ -phenylene-bis-(dithiocarbamate), dark brown in colour was obtained. It was filtered (unwashed), suspended in 60 ml. of water and treated with stirring, with 35 g. (0.3 mole) aq.

sodium chloroacetate at  $\approx 25^\circ\text{C}$ . and pH 7. The mixture containing ammonium-*m*-phenylene-bis-(*S*-carboxymethylthiocarbamate) was allowed to stand for 1 hr. An aq. solution of 52 g. (0.38 mole) anhydrous zinc chloride (or chloride of a heavy metal having a standard potential between +0.14 to +1.1, e.g., Fe, Mn, Sn, etc.) was then added gradually with vigorous stirring. A precipitate of zinc-*m*-phenylene-bis-(*S*-carboxymethylthiocarbamate) that formed, was immediately decomposed by the simultaneous addition of 4N NaOH at such a rate as to maintain pH  $\approx 7$ . The *m*-phenylenediisothiocyanate was recovered from the mixed reaction products by extracting thrice with 100, 50, and 35 ml. portions respectively of acetone. Evaporation of the solvent, and recrystallisation of the product from acetone furnished pale yellow needles of the diisothiocyanate (26 g.), m.p.  $55^\circ$  (lit.<sup>5</sup>  $55.5^\circ$ , pet. ether). The product was also identified by preparing its derivative, *m*-phenylene-di-(1-tetrazoline-5-thione),<sup>1</sup> m.p.  $178^\circ$  (lit.  $179^\circ$ ).

Department of Chemistry, UMESH AGARWALA.  
Indian Institute of Technology, G. S. JOHAR.  
Kanpur, June 19, 1968.

1. Lieber, E. and Slutkin, R., *J. Org. Chem.*, 1962, 27, 2214.
2. Billetter, O. and Steiner, A., *Ber.*, 1887, 20, 230.
3. Rathke, A., *Ann.*, 1873, 167, 218.
4. U.S. Pat. 2681358, 1954.
5. Campbell, T. W. and Tomin, E. A., *J. Polymer Sci.*, 1962, 62, 379.
6. German Pat. 700436, 1936.

#### ADSORBABILITY OF ORGANIC MOLECULES AT Hg/AQUEOUS M/10 SODIUM SULPHATE INTERPHASE

The work of Barradas *et al.*<sup>3</sup> indicates that the value of 'K', the adsorption coefficient as defined by Blomgren *et al.*<sup>1</sup> and ' $\beta$ ' the adsorption index as used by Laitinen and Moisier<sup>2</sup> are in close agreement. Hence it can be concluded that for the analysis of the behaviour of the adsorbates at metal-electrolyte interphase it is sufficient to consider either of the two quantities. The adsorption coefficient 'K' ( $\text{cm}^3 \text{ mole}^{-1}$ ) can be obtained from the equation given by Blomgren *et al.*<sup>1</sup> as

$$\Gamma_A/(\Gamma_m - \Gamma_A) = K C_A \quad (1)$$

where  $C_A$  is the concentration of adsorbate in mole  $\text{cm}^{-3}$ ,  $\Gamma_A$  is the surface excess of the adsorbate and  $\Gamma_m$  is its experimentally observed highest value of surface excess.

Four B.D.H. AnalaR compounds, viz., methanol, allyl alcohol, dioxan and phenol have been studied using dropping mercury electrode (DME) in aqueous M/10 sodium sulphate solution at  $25.0^\circ\text{C}$ . Concentration of the organic compounds was varied from 0.01 to 0.50 M. Electrocapillary data were obtained from accurate determination of drop times of a DME. Sargent capillaries were employed. The drop times measured by an electronic drop counter were accurate upto 0.001 sec. Corbusier and Gierst equation<sup>4</sup> was employed to convert the drop times into the interfacial tension values. The potential on the DME was altered in steps of 0.5 volt in the range  $-0.1$  to  $-1.5$  volt measured against a normal calomel electrode with a Cambridge Pye potentiometer. The  $\Gamma_A$  values were computed using the expression (which can be derived from the Gibbs adsorption isotherm)

$$(\partial \nu / \partial \mu)_E = -\Gamma_A$$

where ' $\nu$ ' is the interfacial tension, ' $\mu$ ' is the chemical potential of the adsorbate, and 'E' is the polarising potential on the DME. The adsorbabilities in terms of the adsorption coefficient 'K' ( $\text{cm}^3 \text{ mole}^{-1}$ ) have been evaluated and written in Table I.

TABLE I

Adsorbabilities of organic substances on mercury at the point of zero charge in terms of 'K' ( $\text{cm}^3 \text{ mole}^{-1}$ ) for different surface coverages ( $\theta = \Gamma_A/\Gamma_m$ ) a, b, c and fixed concentration ( $C_A$ ) d

Substance	'K' for $\theta=0.10$ (a)	'K' for $\theta=0.25$ (b)	'K' for $\theta=0.50$ (c)	'K' for $C_A=0.10\text{M}$ (d)
Methanol	$0.44 \times 10^4$	$0.39 \times 10^4$	$0.52 \times 10^4$	$0.40 \times 10^4$
Allyl alcohol	$0.27 \times 10^4$	$0.41 \times 10^4$	$0.62 \times 10^4$	$0.48 \times 10^4$
Dioxan	$0.48 \times 10^4$	$0.48 \times 10^4$	$0.93 \times 10^4$	$0.82 \times 10^4$
Phenol	$1.10 \times 10^4$	$1.58 \times 10^4$	$2.43 \times 10^4$	$0.98 \times 10^4$

It is seen from Table I that a regular trend in the degree of adsorbability which is related to the physical properties of the adsorbates is obtained when 'K' values are compared for constant surface coverage or for constant concentration, e.g., phenol has the highest 'K' as also density and molecular weight among the compounds investigated. For the same concentration or for the same surface coverage of adsorbates (methanol, allyl alcohol, dioxan and phenol) the adsorbability at the point of zero charge decreases in the order (cf. Table I).

Phenol > Dioxan > Allyl alcohol > Methanol.

Comparison of surface excess values of these adsorbates at the point of zero charge gives also the same order of variation, e.g.,

Phenol ( $4.85 \times 10^{-10}$ ) > Dioxan ( $1.60 \times 10^{-10}$ ) > Allyl alcohol ( $1.10 \times 10^{-10}$ ) > Methanol ( $0.93 \times 10^{-10}$  mole cm.<sup>-2</sup>) at  $C_A = 0.10$  mole litre<sup>-1</sup>.

These observations indicate that greater the (K) value, the greater is the surface activity of the adsorbate.

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Department of Chemistry, M. V. RAMAN MURTI.  
Faculty of Science, NAGENDRA SINGH.  
Banaras Hindu Univ.,  
Varanasi-5, June 19, 1968.

1. Blomgren, E., Bockris J. O. M. and Jesch, C., *J. Phys. Chem.*, 1961, **65**, 2000.
2. Laitinen, H. A. and Moiser, B., *J. Am. Chem. Soc.*, 1958, **80**, 2363.
3. Barradas, R. G. and Hamilton, P. G., *Can. J. Chem.*, 1965, **43**, 2468.
4. Corbuser, P. and Gierst, L., *Anal. Chim. Acta*, 1956, **15**, 254.

#### THERMODYNAMICS OF Cu(II)-5-iodo-8-HYDROXY QUINOLINE-7-SULFONATE

The colourless complex formed by the interaction of copper and 5-iodo-8-hydroxy quinoline-7-sulfonic acid has been studied spectrophotometrically to determine the composition, stability constant and thermodynamic properties like  $\Delta F$ ,  $\Delta H$  and  $\Delta S$ , associated with the formation of the complex.

Absorbance measurements were made on a Hilger Uvispec Spectrophotometer (Model H 700-308), equipped with thermoplates to stabilise the temperature of the cell holder. pH measurements were done with a Beckman pH meter. Reagent solutions were made by dissolving  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  (B.D.H.) and the sodium salt of 5-iodo 8-hydroxy quinoline-7-sulfonic acid in double distilled water.

The nature of the complex was studied by the method of Vosburg and Cooper<sup>1</sup> and it was found that only one complex was formed under the conditions of study with  $\lambda_{\text{max}}$  at 262 m $\mu$ . The effective pH range for the stable existence of the complex was found to be between 1 and 3. The composition of the complex was established by three independent methods: the continuous variation method of Job;<sup>2</sup> the mole-ratio method of Yoe and

Jones<sup>3</sup> and the slope-ratio method of Harvey and Manning.<sup>4</sup> The results indicated that one mole of copper reacted with two moles of the reagent to form a stable complex in solution.

The stability constant of the complex was calculated by the method of Banerji and Dey<sup>5</sup> and the mole-ratio method. In view of the difficulty in obtaining the thermodynamic stability constant (and hence  $\Delta F^\circ$ ) we have determined the stability constants of the complex at various temperatures at a fixed ionic strength of 0.02 and pH 3 (Table I).

TABLE I

Temp.	25° C.	30° C.	35° C.	40° C.	45° C.
log K	9.6	9.64	9.71	9.78	9.82
$\Delta F$ (k.cal./mole.)	-13.15	-13.40	-13.76	-13.98	-14.36
$\Delta S$ (e.u.) ..	59.4	59.3	59.1	59.3	59.5

From the slope of the curve obtained by plotting log K against  $1/T$ , the enthalpy change  $\Delta H$  of the reaction has been calculated and found to be 4.57 k cal. Assuming this to be constant over a range of experimental temperatures,  $\Delta S$  of the reaction has also been calculated by Gibbs-Helmholtz equation and found to be 59.3 e.u.

Determination of stability constant of the complex at various ionic strength shows that the value of K decreases with an increase in the ionic strength, as expected, but beyond ionic strength 0.3 the value of K remains almost constant, probably due to the fact that the activity coefficient of an ion passes through a minimum as the ionic strength increases.

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Chemical Laboratories, K. BALACHANDRAN.  
Birla Institute of SAMIR. K. BANERJI.  
Technology and Science,  
Pilani, Rajasthan, May 29, 1968.

1. Vosburg, W. C. and Cooper, G. R., *J. Am. Chem. Soc.*, 1941, **63**, 437.
2. Job, P., *Ann. Chimie.*, 1928, (x) 9, 113; 1936, (xi) 6, 97.
3. Yoe and Jones, *Ind. Eng. Chem. Anal. Ed.*, 1944, **16**, 111.
4. Harvey and Manning, *J. Am. Chem. Soc.*, 1960, **72**, 4488.
5. Banerji, S. K. and Dey, A. K., *Z. Anal. Chem.*, 1961, **179**, 130.

# ANTICONVULSANT ACTION OF SOME BETA ADRENERGIC RECEPTOR BLOCKING AGENTS

It has been observed that antifibrillatory drugs also show anticonvulsant action.<sup>1</sup> Beta adrenergic receptor blocking agents are known to possess potent antifibrillatory action.<sup>2-5</sup> In view of this the present work was undertaken to study the effect of some beta adrenergic receptor blocking agents, viz., propranolol, D-INPEA and MJ-1999 on experimentally induced convulsions in animals.

The drugs were tested against maximum electroshock and leptazol seizures in mice and strychnine convulsions in frogs. All drugs were given as aqueous solutions, one hour prior to the experiment, intraperitoneally in case of mice and in dorsal lymph sac in case of frogs. The control groups were given same amount of saline.

The observations are shown in Tables I and II.

TABLE I

Effect of beta blocking agents on maximum Electroshock seizures induced in mice by supra maximal A.C. current of 50 mA, 300 C.S. and 0.2 sec. duration

Drugs	No. of animals	Tonic extensor phase present in
Control	.. 10	10
Propranolol 20 mg./kg.	.. 10	No convulsion at all
MJ-1999 80 mg./kg.	.. 10	10
D-INPEA 80 mg./kg.	.. 10	10

TABLE II

Effect of beta blocking agents on leptazol induced seizures in mice Leptazol 100 mg./kg. I.P.

Drugs	No. of animals	Tonic extensor phase present in	Per cent. mortality
Control	.. 10	10	100
Propranolol (20mg./kg.)	10	Nil	40
MJ-1999 (80 mg./kg.)	10	6	60
D-INPEA (80 mg./kg.)	10	10	100

Propranolol 20 mg./kg. I.P. one hour before the test offered a 100% protection against maximal electroshock seizures, whereas other drugs offered no protection and no change in seizure pattern in the dose mentioned.

Propranolol 20 mg./kg. offered 100% protection of the tonic extensor phase of Leptazol

induced convulsions and prevented death in 60% animals. MJ-1999 (80 mg./kg.) also offered 40% protection in the dose tested in this series.

Strychnine test was carried out in 40 frogs. No drug could offer any protection against strychnine induced convulsions.

In the present study propranolol was found to possess significant anticonvulsant property as evidenced by the complete protection it offered against maximal electroshock seizures and abolition of tonic extensor component in Leptazol induced seizures. MJ-1999 also showed partial protection from Leptazol induced seizures only. Comparing the two, MJ-1999 was much weaker than propranolol. Failure of these drugs to antagonize strychnine induced convulsions in frogs might indicate that these drugs produce the anticonvulsant effect by acting on higher centres in the brain.

Since D-INPEA has not shown any anticonvulsant effect, the mechanism of the anticonvulsant action of propranolol and MJ-1999 is unlikely to be due to their beta adrenergic blocking property but some other pharmacological actions may be responsible for this. Propranolol and MJ-1999 have been reported to rise rat brain 5-HT levels,<sup>6</sup> and propranolol has also been reported to inhibit monoamine oxidase enzyme.<sup>7</sup> Anticonvulsant drugs are known to possess both these properties.<sup>8,9</sup>

Dept. of Pharmacology, M. V. NATU.  
M.G.M. Medical College, DEEPAK BOSE.  
Indore (M.P.), India, I. S. GANDHI.  
June 12, 1968. C. B. SETH.

1. Striade and Stoica *Epilepsia.*, 1960, **1**, 264.
2. Moran *et al.*, *The Jour. of Pharm.*, 1962, **3**, 327.
3. Sekya and Williams, *Brit. J. Pharm.*, 1963, **21** (3), 473.
4. Somani *et al.*, *The Jour. of Pharm.*, 1966, **151** (1), 32.
5. Stock and Dale, *Brit. Med. Jr.*, 1963, **2**, 1230.
6. Agarwal *et al.*, *Curr. Sci.*, 1967, **36**, 485.
7. Bose, R. *et al.*, *Ibid.*, 1968, **37**, 169.
8. Bonnycastle, Giarman and Paasonen, *Brit. J. Pharmacol.*, 1957, **12**, 228.
9. Prockop, Shore and Brodie, *Ann. N.Y. Acad. Sci.*, 1959, p. 80.

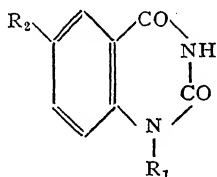
## 1-SUBSTITUTED QUINAZOLINDIONES

As an extension to our work on Quinazolinones,<sup>1,2</sup> a few 1-substituted Quinazolin-2, 4-diones have been synthesised.

The compounds listed in Table I were all prepared by heating the corresponding N-substituted anthranilic acids with 8-10 equivalents of urea for 4-5 hours between 200 and 250°. The

Quinazolidinones reported were isolated in 40-60% yields. The N-substituted anthranilic acids required for the synthesis of the Quinazolidinones, were all prepared by standard literature methods.

TABLE I



No.	R <sub>1</sub>	R <sub>2</sub>	m.p. °C.	Nitrogen %	
				Found	Calc.
I	CH <sub>3</sub>	H	263-64 (Lit. <sup>3</sup> m.p. 264-65)	16.05	15.92
II	C <sub>2</sub> H <sub>5</sub>	H	198-200	14.96	14.73
III	CH <sub>3</sub>	Cl	296-99	13.38	13.30
IV	C <sub>2</sub> H <sub>5</sub>	Cl	264-66	12.28	12.47
V	C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> (2)	H	245-46	11.48	11.11
VI	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub>	H	206-08	10.92	11.11
VII	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (4)	H	268-69	10.55	10.45
VIII	C <sub>6</sub> H <sub>4</sub> Cl (3)	H	220-21	10.47	10.28
IX	C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> (4)	H	258-60	10.96	11.11
X	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> Cl (3)	H	235-38	9.52	9.15
XI	C <sub>6</sub> H <sub>4</sub> Cl (2)	H	280-81	10.43	10.28
XII	C <sub>6</sub> H <sub>3</sub> OCH <sub>3</sub> (2)	H	247-49	10.28	10.45
XIII	C <sub>6</sub> H <sub>3</sub> (H <sub>3</sub> Cl) (2, 3)	H	274-76	9.42	9.77

A typical experiment is described below:

1-o-Tolyl-1, 2, 3, 4-Tetrahydroquinazolin-2, 4-dione.—N-o-Tolylantranilic acid (4.5 g.; 0.02 mole) and urea (12 g.; 0.2 mole) were ground together to a fine powder and then heated at 220° for five hours. The solid reaction product was washed with hot water (50 ml.) and then taken up in 2 N sodium hydroxide solution (40 ml.). The alkaline extract was clarified with carbon and then acidified with conc. hydrochloric acid to congo red. The crude title product thus obtained was crystallized from alcohol; m.p. 245-46°. Found: N, 11.48; Calc. for C<sub>15</sub>H<sub>12</sub>N<sub>2</sub>O<sub>2</sub>: N, 11.11%.

Sarabhai Research Centre, S. SOMASEKHARA.  
Wadi Wadi, V. S. DIGHE.  
Baroda, June 15, 1968. S. L. MUKHERJEE.

1. Somasekhara, S., Shah, G. M. and Mukherjee, S. L., *Curr. Sci.*, 1964, **33**, 521.
2. —, Dighe, V. S. and Mukherjee, S. L., *Ibid.*, 1964, **33**, 645.
3. Seide, O., *Ann.*, 1924, **440**, 311; *Chem. Abstr.*, 1925, **19**, 1282.

## ACTION OF DDT ON THE PERIPHERAL NERVOUS SYSTEM OF THE GRASS FROG *RANA PIPIENS*

THE pathology of DDT in animals is rapidly becoming well documented. Gordon and Welch<sup>1</sup> have shown that in arthropods DDT works directly on the nerves. Much of the work on the vertebrates indirectly indicates the CNS as the target organ though there are many reports of other areas of the body being affected by chronic exposure (King<sup>2</sup>). Dale *et al.*<sup>3</sup> have shown that when pigeons, rats and dogs are treated with DDT they become hyperactive and show signs of tremor as the course of intoxication progresses.

Grass frogs were used as the experimental animals. Fifty control animals were injected with 0.2 ml. of ethyl alcohol and 50 experimental animals were similarly injected with a dose of DDT dissolved in the alcohol equivalent to 100 ppm based on total body weight.

Both groups exhibited low activity levels for approximately the first 6 hours in an actograph. Then the experimental group demonstrated a dramatic increase in activity which was maintained until death while the controls did not exhibit this increase. This increased activity consisted of violent lateral and rearward extensions of the hind legs.

In a second series of experiments, the spinal cord of both groups was severed just anterior to the junction of the three trunks of the sciatic nerve, after the experimental group showed signs of increased motor activity. As the cord was cut, both groups extended their legs and then retracted them slowly towards the body. When the animals were left unstimulated only the experimental group made consistent spontaneous leg extensions. If the cord was severed after the experimental animals reached an advanced state of intoxication as indicated by their lying rigidly with the hind legs extended and quivering slightly, no retraction of the legs occurred. If the legs were forcibly moved into the body simulating a normal resting position, they were soon extended. The cutting of the sciatic nerve eliminated this re-extension.

These studies indicate that the peripheral nervous system is intimately involved with the behaviour associated with DDT intoxication. It is, therefore, possible that DDT could eliminate local populations of some species not only by a direct killing action mediated through the CNS but by a chronic exposure to the pesticide



acting through the peripheral nervous system which causes a behavioral upset and would place the animal at a selective disadvantage.

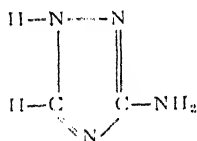
147 Howard Street, PETER A. ISAACSON.  
Port Jefferson Station,  
New York, June 12, 1968.

1. Gordon, H. T. and Welsh, J. H., *J. Cell. Comp. Physiol.*, 1948, **31**, 395.
2. King, S. F., *U.S. Fish and Wild. SSR-Fish No. 399*, 1962.
3. Dale, W. E., *et al.*, *Arch. Inst. Pharmacodyn.*, 1966, **162** (1).

### OBSERVATIONS ON THE REGENERATION OF PLASTIDS

The question of the origin of plastids whether *denovo* or by division of pre-existing plastids has been mooted for a long time although at present the consensus is that they multiply by division of pre-existing plastids and transmitted to subsequent generation through cytoplasm of the egg only according to the maternal inheritance pattern and that plastids once lost from a cell cannot be regenerated by that cell.<sup>1,2</sup> Presently, a case of plastid formation in cells depleted of plastids has been observed which is suggestive of the fact that not only the maintenance but the origin of plastids is under control of the genetic material DNA in the cytoplasm.

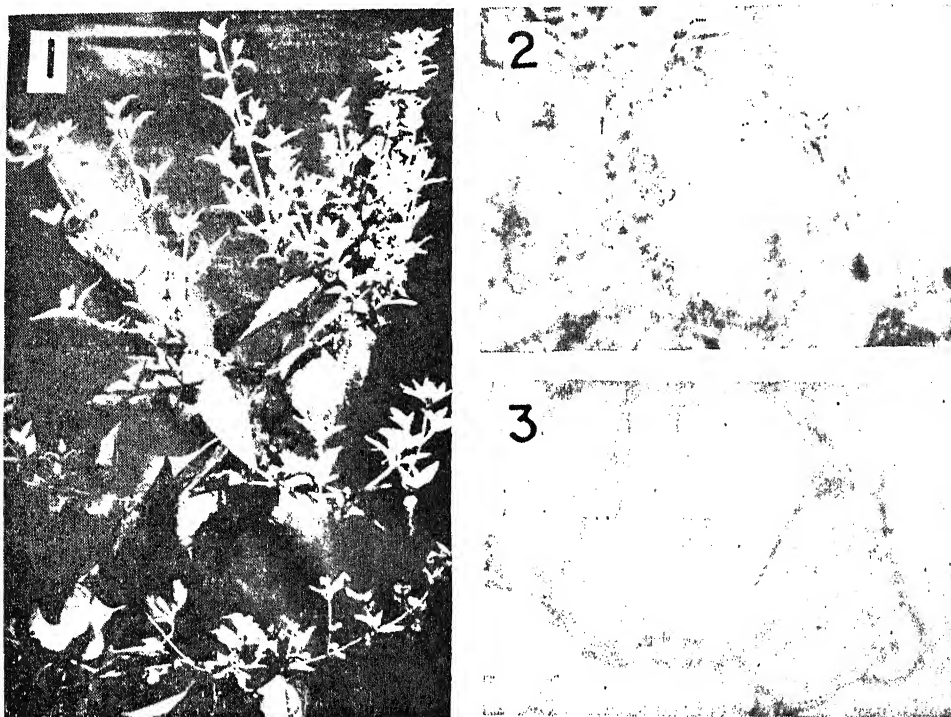
The herbicidal chemical 3-amino-1, 2, 4-triazole,



(AT) at concentrations higher than 800 ppm. has been observed to destroy all chlorophyllous tissues of plants accompanied by dehydration and ultimate death of affected cells. However, under sublethal concentrations, i.e., below 400 ppm, it is observed to selectively destroy the chloroplasts without causing any apparent injury to the nucleus and other parts of the cytoplasm. Thus the tissues formed subsequent to sublethal AT absorption were characterised by chlorosis, the affected part remaining whitened for several weeks but eventually regaining their green colour through formation of new chloroplasts.

Sublethal concentrations of the herbicide AT at 300 ppm. and 200 ppm. were applied to actively growing shoot buds of *Eupatorium odoratum* and *Rhæo discolor* by camel hair-brush. In order to ensure continuous and uniform absorption of AT these buds were kept covered by cotton-wool moistened with the AT solution for a minimum period of 12 hr. after which the chemical was washed off by water. The treated plants were kept under observation for several weeks for noting the responses.

Initially there was retardation in the rate of growth of the treated buds. Localised development of chlorotic patches accompanied partly by dehydration of the affected tissues was observed particularly under higher concentration used. The degree of chlorosis varied with the concentration of AT and age of tissue. In this respect the younger cells were more affected than older ones. A still more pronounced effect of AT absorption subsequently noted was the complete whitening of the chlorophyllous parts of the newly formed leaves on the main stem of *Rhæo* and the terminal and axillary branches of *Eupatorium* continuously up to the 4th or 5th node (Fig. 1). In *Rhæo* the chlorophyll bearing ventral side of the leaves formed after AT application alone remained whitened while the anthocyanin pigmentation on the dorsal side of leaves was unaltered indicating apparently that AT has a selective destructive action on chlorophyll. After continuous production of non-chlorophyllous completely whitened, leathery leaves for 4-5 weeks (i.e., upto the 4th, 5th nodes) leaves subsequently produced developed green patches on it indicating reappearance of chlorophyll. This was followed by production of leaves which were entirely green with well-developed chloroplasts inside their cells. To investigate further the process of whitening transsections of leaves and apical meristematic regions whitened by AT application were examined. Light microscopic studies revealed that their cells were completely depleted of all plastids (Figs. 2 and 3). These were compared with similar transsections of white regions of naturally variegated leaves of other plants which showed presence of colourless plastids in their cells, although the green plastids were absent. This observation undoubtedly indicates that whitening of leaves after AT application is not by mutation of chloroplasts to colourless plastids but by a



FIGS. 1-3. Fig. 1. A branch of *Eupatorium odoratum* formed from a bud treated with sublethal concentration of AT showing completely whitened leaves and stem. Fig. 2. T.S. of normal leaf of *Rheo discolor* showing plastids in cells (*n*, nucleus; *pl*, plastid). Fig. 3. T.S. of AT treated leaf of *R. discolor* showing complete absence of plastids in cytoplasm. Nucleus (*n*) unaffected.

complete disintegration and depletion of all plastids from those cells.

Now it is interesting to know how the chloroplasts reappeared in tissues devoid of any plastid. Since there was no intact plastid in the AT treated cells the possibility of plastid formation through multiplication of pre-existing plastid can be ruled out. It is possible that plastids were synthesised anew in the subsequently formed tissues by the plastid forming submicroscopic remnants, namely, organelle chloroplast DNA left behind in the cytoplasm which remained undestroyed or unaffected by AT application.

Univ. Dept. of Botany,  
Calicut-8, April 27, 1968.

K. GEORGE.

#### PHENOLS IN RELATION TO RESISTANCE OF SUGARCANE VARIETIES TO RED ROT DISEASE\*

THE economic importance of the red rot disease of sugarcane and the relative rarity of resistance to it, particularly in varieties combining this character with other desirable commercial qualities, emphasizes the desirability of an understanding of the nature of resistance to the disease. Among various biochemical factors determining the resistance of plants to fungal diseases, certain polyphenols have been recorded to play an important role. While reviewing the physiology of resistance to fungal diseases in plants, Harve<sup>2</sup> stressed the importance of phenols and related compounds as also polyphenol oxidase (PPO) enzyme in the phenol defence mechanism. In the case of scab and *verticillium* wilt of potatoes, chlorogenic acid and total phenols were found to be more in resistant varieties than in susceptible ones. Chlorogenic acid is reported to be associated with resistance to coffee

1. Garnick, S., *Handbuch Der Pflanzen physiologie*, Ed. Ruland, W., Springer-Verlag, Berlin, Germany, 1955, **1**, 507.
2. Muhlethaler, K. and Frey-Wyssling, A., *J. Biophys. and Biochem. Cytol.*, 1959, **6**, 507.
3. Wolken, J. J., *Ann. Rev. of Plant Physiol.*, Annual Reviews, Inc., California, U.S.A., 1959, **10**.

canker (*Cyrtocytis fimbriata*) and to apple scab. Abbott<sup>1</sup> found that varieties showing resistance to the red rot disease registered a higher phenolic content in the juice than the susceptible ones. In the bottom internodes the phenolic content in resistant Co. 281 was approximately 50% greater than in the susceptible POJ 213 and in the upper internodes 70.0% greater. Parthasarathi and Vijaya-saradhy<sup>2</sup> reported that the wild species of sugarcane, *S. spontaneum* in general, had a higher level of phenolic content than the cultivated hybrid canes. Srinivasan<sup>3</sup> studied the PPO activity in relation to temperature and resistance to red rot in sugarcane. Oxidation of phenols to quinones should improve a plant's defences, but further polymerization to melanins may or may not favour resistance.

(i) Co. 349, Co. 980 and Co. 1148 (resistant to red rot); (ii) Co. 617 and Co. 622 (moderately resistant); (iii) Co. 658 and Co. 419 (moderately susceptible); (iv) Co. 213, Co. 312, Co. 997 and Co. L. 29 (susceptible).

The inoculation was done by the standard standing cane technique using strain 'D' of the fungus. The phenolic content in fresh expressed stem juice was determined by the diazotised sulphanilic acid method<sup>3</sup> while the PPO was estimated by measuring the change in O.D. (Klett's reading) using catechol and acetate buffer, pH 5.0.<sup>4</sup>

From control and inoculated plants, the phenolic content and PPO were estimated at monthly intervals from September to December (for the January planted crop). The results

### PHENOLIC CONTENT AND POLY PHENOL OXIDASE (PPO) ENZYME ACTIVITY (IN RELATION TO RED ROT RESISTANCE)

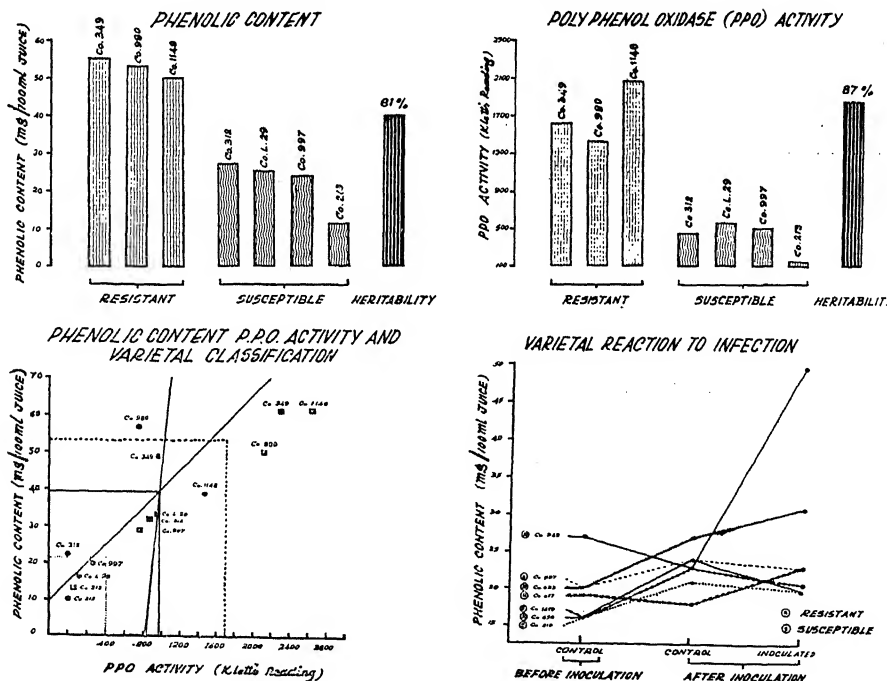


FIG. 1

In the present studies, the results obtained from a study of the phenolic content (control and inoculated plants) and PPO in fresh expressed stem juice in certain red rot resistant and susceptible cane varieties are reported. The following eleven commercial hybrid varieties known for their reaction to the disease were taken up for the study, viz.,

are depicted in Fig. 1 and are summarised as below :

A highly significant difference has been found in the native phenolic content of the cane juice between resistant and susceptible cane varieties, being higher in the former and agreeing with the observations made by Abbott (Fig. 1, top left).

The activity of PPO is more in resistant varieties as compared to susceptible ones (Fig. 1, top right).

When the two classes of varieties are artificially inoculated and the quantity of phenols estimated, a very high liberation of these compounds in the resistant varieties is seen; while there is no increase, there is evidence of even a decrease in the susceptible ones (Fig. 1, bottom right). Similarly, in the case of PPO, the resistant ones maintained a higher level of activity before and after inoculation as compared to susceptible ones.

From the present studies, a relationship between the higher phenolic content and PPO activity on one hand and adult resistance to red rot is discernible. The characters appear to be basically varietal in nature as indicated by the heritability values (being 81% for phenols and 87% for PPO) and a threshold value could be worked out by reciprocal regression curves bringing about the differentiation between the two classes—resistant and susceptible (Fig. 1, bottom left).

Thanks are due to Dr. K. V. Srinivasan, Plant Pathologist (PL. 480), for suggestions and to Shri K. Parthasarathi, Ex-Sugarcane Chemist, for recording some of the preliminary observations.

Sugarcane Breeding	K. CHIRANJIVI RAO.
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Coimbatore-7,	E. LALITHA.
May 15, 1968.	V. K. RAJALAKSHMI.

\* Approved for publication by the Director, Sugarcane Breeding Institute, Coimbatore-7.

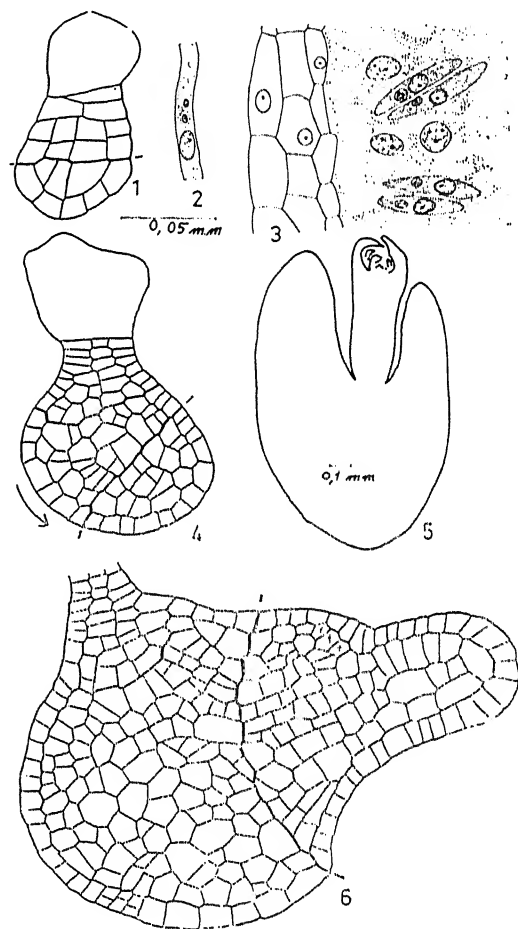
1. Abbott, E. V., "Red rot of sugarcane," *Tech. Bull.* No. 641, Nov. 1938, U.S. Dept. of Agric., Washington, D. C.
2. Hare, C. R., *Bul. Rev.*, 1966, **32** (2), 95.
3. Parthasarathi, K. and Vijayasardhy, M., *Curr. Sci.*, 1958, **27** (6), 218.
4. Ponting, J. D. and Joslyn, M. A., *Archiv. Biochem.*, 1948, **19**, 47.
5. Srinivasan, K. V., *Curr. Sci.*, 1968, **37** (2), 35.

#### PRELIMINARY NOTE ON THE EMBRYOLOGY OF *DIPLANTHERA* *UNINERVIS* ASCHERS\*

*Diplanthera*, one of the five genera of the Potamogetonaceae known from Madras State, is not known embryologically. It is a submerged herb found in the back waters of Ennore near Madras.

Anthers are bitheous, inserted one above the other. The anther wall, 3- or 4-layered,

remains without fibrous thickening. Tapetum develops into a periplasmodium. The microspore mother cells are longitudinally elongate and arranged end to end. Probably the tetrads of microspores separate from the configuration along their longitudinal axis. After the 2-celled stage, the pollen grains stretch considerably, which can be compared with that of *Phyllospadix* where it attains a length of 1 mm.<sup>1</sup> This type of filiform pollen grain is different from what has been described for *Halophila* of Hydrocharitaceae. Confirming the observations of Brewbaker (1967) this submerged aquatic form also shows 3-celled condition when the pollen grain is shed.



FIGS. 1-6. *Diplanthera uninervis*. Figs. 1, 4 & 5. Longisection of the embryo at successive stages of development. Fig. 5. Same in a plane right angles to those of others. Fig. 2. Part of a mature pollen grain. Fig. 3. Part of the anther (Magnification—same for all except for Fig. 5).

The ovary, with its style laterally exerted, consists of a single bitegmic ovule. The development of the embryo-sac conforms to the normal 8-nucleate type.

The endosperm is *ab initio* nuclear. The nuclei are of diverse shape and size. They are found accumulated in distinct groups all along the periphery.

The basal cell of the two-celled proembryo remains without further division. The derivatives of the terminal cell, besides the embryo proper, give rise to a multiseriate suspensor. Even before the terminal tier becomes active, the cells of the subterminal tier begin to enlarge, rapidly on one side, so as to push the terminal tier to a lateral position in relation to the long axis of the undifferentiated proembryo. The peripheral cells of this subterminal tier, at the proximity of the terminal tier, divide actively, grow upwards and all around, forming a cup-like sheath surrounding the derivatives of the terminal tier.

The cells of the terminal tier divide transversely. The lower group of cells, thus formed, divide and elongate to push the upper group of cells that constitute the cotyledon and epicotyl farther away from the subterminal tier. The cotyledonary locus is active from the beginning whereas the epicotylary one becomes active after a considerable time.

Department of Botany, K. K. LAKSHMANAN,  
Pachaiyappa's College,  
Madras-30, May 6, 1968.

\* Contribution No. 12, Department of Botany, Pachaiyappa's College, Madras.

1. Dudley W. R., *Wilder Quarter Century Book*, Ithaca, N.Y., 1893, p. 403.
2. Brewbaker, J. L., *Amer. J. Bot.*, 1967, **54**, 1069.

### CEPHALOSPORIUM KASHIENSIS SP. NOV., FROM SOIL

DURING investigation on rhizosphere mycoflora of *Linum usitatissimum* Linn. a new species of *Cephalosporium* was isolated. The cultural study of the fungus was done at 25° C. on Czapek's agar medium.

*Cephalosporium kashiensis* Sp. Nov.

Mycelium grows slowly in culture. Aerial mycelium dense, at first yellowish-white, becoming "Café crème" (Maerz and Paul, 1930, Pl. 14, D-8). Reverse of the colony horse-chestnut (Pl. 8, J-5). Hyphae generally straight but may be undulate, rich in proto-

plasm and up to 6  $\mu$  broad. Phialides originate from the mycelium, verrucose and up to 135  $\mu$  long, occasionally branched and septate, straight upward and sometimes curved. Spores develop endogenously, leaving the end of the phialide behind as an empty cuff, they aggregate in the slimy clumps. Conidia vary very much in shape and size. The number varies from 5-9 in a clump. Young conidia look like a droplet, older ones cylindrical with rounded ends, 15-37  $\times$  5-15  $\mu$ . Round or oval dark brown chlamydospores measuring 18  $\mu$  in diameter develop aerogenously on hyaline stalks, the latter are occasionally septate, 2-20  $\mu$  long.

The fungus was isolated by G. N. Singh from the rhizosphere of *Linum usitatissimum* Linn. in January 1967 from Banaras Hindu University campus. It is being deposited in Herb. I.M.I., Kew.

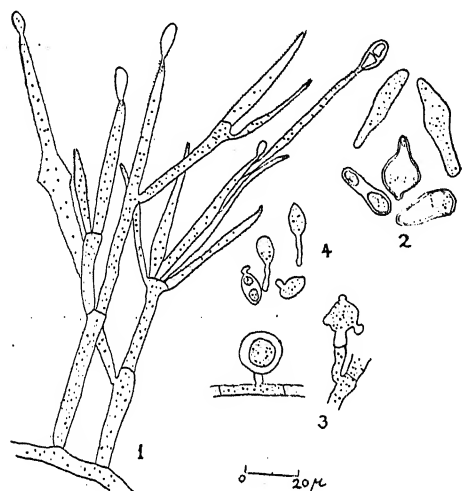
*Cephalosporium kashiensis* Sp. Nov.

Mycelium lente crescens in cultura. Mycelium aereum densum, primo luto-album, tum evadens "Café crème" (Maerz and Paul, 1930, Pl. 14, D-8) Pars versa castanea. Hyphae vulgo rectae, interdum undulatae, abundanter protoplasmate ditae, et ad 6  $\mu$  latae. Phialides emergunt e mycelio, verrucosae, et ad 135  $\mu$  longae, vulgo ramosae, et septatae, sursum rectae, interdum curvae. Sporae endogene evolvuntur, phialidis apice retro relicto ut manica vacua, et aggregatae in massas mucosas. Conidia valde diversae tum formae tum magnitudinis. Numerus variat quinque inter et novem in singulis massis. Conidia juvenilia guttulae similia, maturiora vero cylindrica apicibus rotundis, 15-37  $\times$  5-15  $\mu$ . Chlamydospore rotundae vel ovaes fusco-brunneae, 18  $\mu$  diam. evolvuntur aerogene insidentes stipitibus hyalinis, qui sunt interdum septati, 2-20  $\mu$  longi.

Leetus e rhizosphæra *Linii usitatissimi* Linn. mense januario 1967 a G. N. Singh in Campo universitatis Banaras.

This isolate is similar to *Cephalosporium crotocinigenum* Schwarz (1965) in so far as it concerns the morphology of the phialide and the production of an antifungal substance which inhibits the growth of *Alternaria tenuis*, *Curularia pallescens* and *Helminthosporium euphorbiae* but differs markedly from the same in having spores and chlamydospores of much larger dimension. Therefore a new species *Cephalosporium kashiensis* is being proposed to accommodate it.

The growth of the fungus was found to be the best on Richard's medium in which after a week the diameter of the colony was 42 mm.



FIGS. 1-4. *Cephalosporium kashiensis* sp. nov. Fig. 1. Branched phialides and conidia. Fig. 2. Conidia. Fig. 3. Acrogenous chlamydospores with hyaline stalks. Fig. 4. Germinating conidia.

Sincere thanks are due to Prof. R. Misra for providing laboratory facilities and to Rev. Fr. Dr. H. Santapau for Latin diagnosis.  
Department of Botany, R. Y. ROY.  
Banaras Hindu University, G. N. SINGH.  
Varanasi-5, October 25, 1967.

1. Maerz, A. and Paul, M. R., *Dictionary of Color*, McGraw-Hill Book Co., Inc., New York, 1930.
2. Schwarz, M. B. S., *Trans. Brit. mycol. Soc.*, 1965, 48, 51.
3. Sukapure, R. S. and Thirumalachar, M. J., *Mycologia*, 1966, 58, 351.

#### ON THE IDENTITY OF *TEPHROSIA* *JAMNAGARENSIS* SANTAPAU AND *T. AXILLARIS* A. R. SMITH FROM GUJARAT

A new species of *Tephrosia* Pers., namely *T. jamnagarensis* was described by Santapau in 1958 based on fruiting twigs from Jamnagar in Saurashtra and the type (Santapau 7522) has been deposited in the Blatter Herbarium, Bombay. He could not examine any flowering specimens of the new species but even in the absence of any flowers, it was obviously quite distinct from all other known species of *Tephrosia*. The new species is closely allied to *T. strigosa* Sant. and Mahesh. differing in the structure of leaves, size and form of legumes

and the brevity of the peduncles. Subsequently in the *Flora of Saurashtra* (1962), he has indicated that Shri Ahluwalia has also recollected the same species with young flower buds on 24th August 1954 from Victoria Bridge in Jamnagar. Recently Ahluwalia and Smith (*Kew Bull.*, 1967) have described another new species of *Tephrosia*, viz., *T. axillaris* A. R. Smith from Jamnagar itself based on both flowering and fruiting twigs. An analysis of the description of *T. axillaris* indicates that it fully conforms to the type of *T. jamnagarensis* and the description aptly fits the fruiting twigs and leaves of *T. jamnagarensis*. Moreover, *T. axillaris* is also partly based on the collection from Ahluwalia from Victoria Bridge, the identical locality indicated by Santapau in *Flora of Saurashtra* but the date of collection is given as 25th August 1954. There is no doubt that both *T. axillaris* and *T. jamnagarensis* are identical in all respects, though for the first time the floral details have been described under *T. axillaris*. *T. jamnagarensis* is not so rare and a careful survey is bound to reveal additional localities in Gujarat State.

Since *T. jamnagarensis* has been validly published earlier in 1958, *T. axillaris* should be treated as a synonym under the former species. The citation should now read as follows:

*Tephrosia jamnagarensis* Santapau in *Proc. Nat. Inst. Sci. India*, 24B : 133, t. 1, 1958, et *Fl. Saur.*, 1 : 134, 1962.

*T. axillaris* A. R. Smith in *Kew Bull.*, 21(2) : 311, t. 1, 1967.

We are thankful to Shri R. S. Rao, Botanical Survey of India, and Prof. Bole, St. Xavier's College.

Botanical Survey of India, R. SUNDARA RAGHAVAN.  
7-Koregaon Road, B. M. WADIWA.  
Poona-1, June 13, 1968.

#### METHODS OF CULTIVATION, STANDARDIZATION AND QUANTITATIVE ESTIMATION OF *ENTAMOEBIA HISTOLYTICA*

For my studies on *Entamoeba histolytica* at Carnegie Institute of Technology, Pittsburgh, Pa. U.S.A., I have found the following methods for the cultivation and quantitative estimation of amoeba as very convenient and accurate. The strain of *E. histolytica* used in these studies was first isolated by Tobie (1949) at sigmoidoscopy from a patient with amoebic

dysentery. The organism was later transferred to a dog and subsequently isolated in pure culture. The strain was later maintained by Dr. C. W. Rees of the National Institute of Health, Bethesda, Maryland, and is now known as NIH strain 200. The choice of this strain was made on the basis of its rapid growth, which reaches a maximum count after 48 hr. of incubation, and because of the large size of the trophozoites.

**Cultivation of *E. histolytica*.**—The Modified Shaffer and Frye medium (MS-F) (Reeves, Meleney and Frye, 1957) was used for culturing amoebæ in the laboratory. The MS-F medium consisted of 1.5 g. of thiomalic acid first dissolved in 1000 ml. of distilled water; Trypticase (BBL) 2%; Dextrose (Difco) 1%; sodium chloride, 0.25%; and  $K_2HPO_4 \cdot 3H_2O$ , 2%, adjusted to pH 7.0 with 1 M sodium hydroxide. The medium was dispensed in 12 ml. portions in screw cap tubes (16 mm.) and autoclaved at 121° C. at 15 pounds for 15 min. All inoculations were made into the above medium and incubated at 37° C. over a period of 48 hr.

A second cell line was also maintained on Endamoeba Medium (Difco) (Cleveland and Collier, 1930) slants. An inoculum consisting of 0.5 ml. of a 48 hr. culture of amoeba and 0.5 ml. of penicillin inhibited *Bacteroides symbiosus* cells was used on the slants. The slant culture also received 0.5 ml. each of Horse-Serum-Saline (1:6) (Difco). These slants were incubated at 37° C.

**Standardization of Organism for Inoculum.**—A 48 hr. culture of *B. symbiosus* grown in thioglycollate medium was centrifuged and the cells were suspended in 0.85% physiological saline. The turbidity was adjusted to 35% T with a Bausch and Lomb Spectronic 20 Spectrophotometer at a wavelength of 650 mμ. The bacterial count was established in Levy's Hemacytometer counting chamber. A saline suspension of *B. symbiosus* at 35% transmittance has a total count of  $6.5 \times 10^6$  cells per ml. In all experiments 0.5 ml. of the above standardized penicillin inhibited cells was used as an inoculum.

A 48 hr. old culture of *E. histolytica* strain NIH 200 grown in 12 ml. portions of MS-F

medium gives approximately  $4 \times 10^5$  trophozoites per ml. as counted in Levy's chamber. An inoculum of 0.5 ml. of this culture was used in all experiments.

**Methods of Enumerating the Amœbæ.**—All counts were made using a Levy's hemacytometer. The standard procedure used in counting the amœbæ was to make a 1:10 dilution of 1 ml. of amœba culture in MIF (Merthiolate-Iodine-Formalin) saline solution. The MIF (Sapero and Lawless, 1953) gives a bright colour stain to the amœbæ. The MIF stain-fixative consists of 10% solution of Tincture of Merthiolate (No. 99 Ely Lilly and Co. 1:1000) in distilled water; 10% formaldehyde (USP); and 2% glycerin. To each 1 ml. of MF is added 0.1 ml. of freshly prepared 5% Lugol's solution.

MIF stain-fixative is a recommended procedure used by the U.S. Naval Medical Center for the identification of amœbæ in the stool specimens. In this research (Ahmad, 1964), however, the stain was exclusively used for counting amœbæ in the Levy's chamber. Each 1 ml. of amœba culture to be counted was added to 3 ml. of MIF and 6 ml. of physiological saline. This gives 1:10 dilution of the culture in which all amœbæ are fixed and stained. Counting in this manner minimizes the chances of overlooking the amœbæ in the chamber, and moreover, because of 1:10 dilution of the culture, there are fewer bacteria under the field. All counts were made in duplicate, counting all squares in the central chamber. An average of two counts was used for establishing the final number.

Dept. of Biology,  
Delhi College,  
Delhi, May 23, 1968.

SOHAIL AHMAD.

1. Ahmad, Sohail, *Thesis*, Dept. of Biol. Sci., Carnegie Inst. of Technology, Pittsburgh, Pa. U.S.A., 1964.
2. Cleveland, L. R. and Collier, J., *Am. J. Hyg.*, 1930, 12, 606.
3. Reeves, R. E., Meleney, H. E. and Frye, W. W., *Ibid.*, 1957, 66, 56.
4. Sapero, J. J. and Lawless D. K., *Am. J. Trop. Med. & Hyg.*, 1953, 2, 613.
5. Tobie, J. E., *Ibid.*, 1949, 29, 859.

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## REVIEWS AND NOTICES OF BOOKS

### Catalysis Reviews (Vol. 1: Book Edition).

Edited by Heinz Heinemann. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. vii + 333. Price \$17.50.

This new series, *Catalysis Reviews*, emphasizes the interdisciplinary aspects of catalysis. It is dedicated to the belief that the science of catalysis can best be advanced by avoiding compartmentalization and by critically examining phenomena and observations at the periphery as well as the centre of the field. The series is not limited to only homogeneous and heterogeneous catalysis. Advances in technology as well as theory, both engineering and chemical aspects of catalytic reactions, reactor design, computer models, analytical tools, and statistical evaluations, to name only a few subjects, are reviewed.

The contents of this volume are as follows: Zeolites as Catalysts. I, by John Turkevich; Reactions Catalyzed by Pentacyanocobaltate (II), by Jack Kwiatek; Reactions of Unsaturated Ligands in Pd(II) Complexes, by Eric W. Stern; Application of Computers in Chemical Reaction Systems, by S. S. Grover; Electronic Surface States of Ionic Lattices, by Peter Mark; Reflectance Spectroscopy As a Tool for Investigating Dispersed Solids and their Surfaces, by K. Klier; Importance of the Electric Properties of Supports in the Carrier Effect, by Solymosi; Static Volumetric Methods for Determination of Adsorbed Amount of Gases on Clean Solid Surfaces, by Z. Knor.

This book will be of interest to chemists, solid state physicists, metallurgists, engineers, other scientists in the chemical process industry, and professors of chemistry and related fields.

C. V. R.

### Principles of Adsorption Chromatography: the Separation of Nonionic Compounds (Vol. 3). (*Chromatographic Science Series*).

Edited by Lloyd R. Snyder. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. xvi + 413. Price \$17.50.

Adsorption chromatography is today one of the important and widely used techniques available for the separation and analysis of

complex organic mixtures. Numerous innovations in technique, apparatus, adsorbents, and individual theories of separation have been developed during the past four decades.

This book offers a comprehensive and detailed understanding of the separation of organic compounds by adsorption chromatography. It includes the various techniques of liquid-column, thin-layer, and gas-solid chromatography. The author presents a rational organization of the principles of adsorption chromatography, systematizing, evaluating, and generalizing experience and theory for ready application to given separation problems. This organization enables the neophyte chromatographer to achieve an understanding of the theory and practice of adsorption chromatography and helps the experienced worker improve his ability to separate complex organic mixtures that defy normal attempts at separation.

The contents of this book are: Introduction; The Chromatographic Process and Techniques of Separation; General Aspects of Adsorption; The Importance of Sample Size in Adsorption Chromatography. Isotherm Linearity; Bed Efficiency. Bandwidth versus Separation Conditions; The General Role of Adsorbent Type and Activity; Individual Adsorbents; The Role of the Solvent; Gas-Solid Chromatography; The Role of Sample Structure. Primary Effects; The Role of Sample Structure. Secondary Effects; Separation Temperature as a Variable; and Some Related Topics.

C. V. R.

**The Ecology of Soil Bacteria** (*An International Symposium*). Edited by T. R. G. Gray and D. Parkinson. (Liverpool University Press, 123, Grove Street, Liverpool-7), 1968. Pp. xv + 681. Price 150 sh. net.

This is a companion volume to the *Ecology of Soil Fungi* which has been a valuable reference work to the soil mycologists.

The comparatively small size of the soil bacteria, their nutritional and biochemical diversity, and the difficulties identifying them, have meant that the development of soil bacteriology has been different from that of soil mycology.

In an effort to stimulate work in this field, workers from all over the world participated in an International Symposium designed to emphasize these differences in approach. The present volume presents the thirty-five contributions which were given at this Symposium together with the discussions which were held at the end of each session. Its main sections cover the following subjects: 1. The Environment of Soil Bacteria; 2. Methods for the Isolation and Estimation of Activity of Soil Bacteria; 3. The Physiology of Soil Bacteria; 4. The Taxonomy of Soil Bacteria; 5. Bacteria in the Root Region of Plants; 6. The Growth of Bacteria in Soil.

Further, each contribution is followed by a list of references related to the research considered.

C. V. R.

**Introduction to Business Statistics.** By G. Hadley. (Holden-Day, Inc., 500, Sansome Street, San Francisco 94111), 1968. Pp. 463. Price \$10.75.

The author's book *Introduction to Probability and Statistical Decision Theory* was noticed in these columns, see *Current Science*, 1967, 36, 681. The treatment in the present publication is at a lower mathematical level, and provides topics which can be selected for a one-semester course in business statistics. These include probability theory, random variables, estimation, hypothesis testing, decision theory, quality control, regression and correlation analysis, time series and forecasting. Over 600 problems of varying levels of difficulty are given.

A. S. G.

**Physics Experiments and Projects.** By W. Bolton. (The Pergamon Press, Ltd., Headington Hill Hall, Oxford, England). (1) Properties of Matter, 87 pages; (2) Waves and Particles, 97 pages; (3) Atomic Physics, 109 pages; (4) Electricity, 130 pages. (Flexi-cover). Price 8 sh. 6 d. each.

This series of booklets is intended to provide learning physics through experimental work. The experiments are such that they need only

from ten minutes to a maximum of one hour to complete. It is envisaged that the whole class will be doing the same experiment, so that the theory which is taught becomes essentially a discussion of results.

The Projects given at the end of each book are intended to make the students think and apply the knowledge they have gained to real problems. The whole set has been designed for the G.C.E. Advanced level. This series will be useful to teachers of the P.U.C. of Indian Universities which should correspond to this level.

A. S. G.

**Medicinal Plants.** By S. K. Jain. (Published by the National Book Trust, India, New Delhi-1), Pp. 176. Price Rs. 5.75.

In presenting this popular and useful book the author has selected for description 80 medicinal plants, mostly indigenous, whose efficiency in medicine has been well recognised and tested. In the description of each plant the botanical name is first given followed by the family to which it belongs, and the names in various Indian languages. The trade name of the drug from the plant is then given. There is a short description of the plant, its distribution and the medicinal properties. The author, however, rightly warns the reader not to use any on his own without proper medical prescriptions. There are 67 illustrations of which 12 are in colour, 29 in half-tone, and 26 as line drawings.

A. S. G.

**Research Methods in Plant Ecology.** By S. C. Pandeya, G. S. Puri and J. S. Singh. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), Pp. 272. Price Rs. 30.00.

Essentially written as a practical guide to students of plant ecology the book describes in detail methods for the qualitative and quantitative estimations of all the organic and inorganic elements in all areas of biogeocoenosis. As literature on this practical aspect of the subject is scattered the authors have done a good work in presenting a compact volume for the benefit of the students.

A. S. G.

# THE DIAMONDS OF THE KRISHNA VALLEY

SIR C. V. RAMAN

THE river Krishna and its principal tributary the Tungabhadra flowing respectively in south-easterly and easterly directions enter the area shown in the geological maps as the Kurnool formations. Further on, they meet and join up near a place known appropriately as Sangameswaram. The united stream then flows eastwards through the area known geologically as the Cuddapah formations. The

takes a north-easterly direction in the endeavour to by-pass these obstacles and find a gap through which the waters can flow again southwards. After passing through this gap, the Krishna flows almost due south. It then widens out as it approaches Vijayawada and passing through another gap between high hills flows down into the alluvial plains beyond and then to the sea.

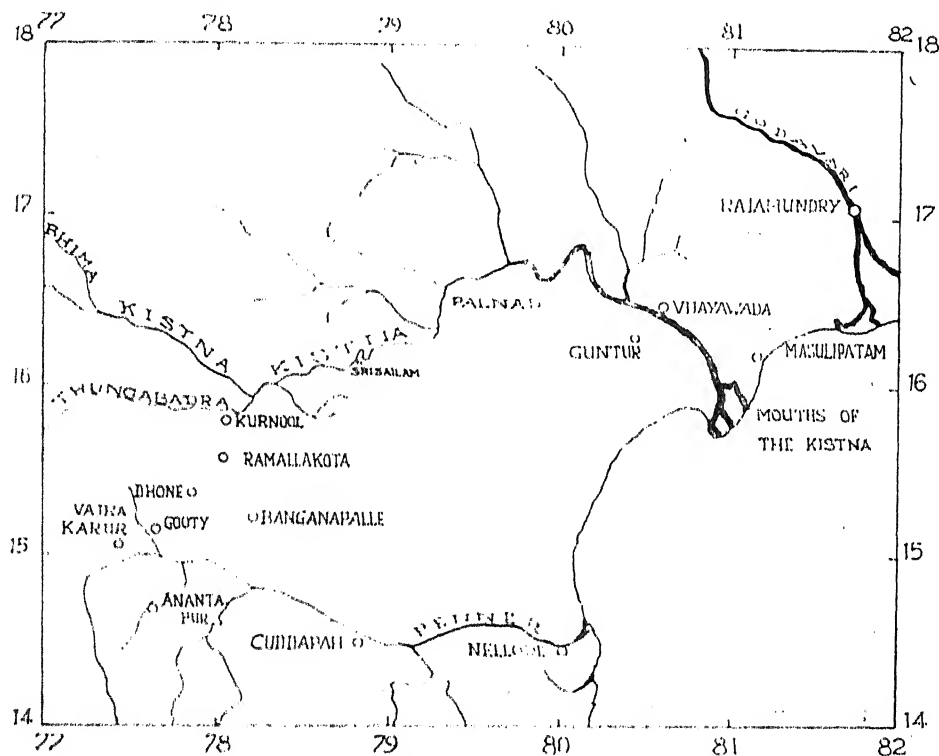


FIG. 1. The River Valleys of the Krishna and the Pennar.

actual course of the river in these formations is very tortuous. The stream exhibits a conspicuous double bend in the vicinity of the famous shrine of Srisailem. Further on, it turns sharply northwards and its path lies outside the Cuddapah formations for a short length. But the river soon returns to the area of those formations and follows a course roughly parallel to their crescent-shaped outline. Towards the end of its course in the area, it curves round and then meets obstacles to its flow in the form of hills of considerable height and extension. As a result, the river

The distance between Sangameswaram and Vijayawada by a straight flight is 178 miles. But measured along the actual path of the river it is no less than 276 miles, the difference arising from the several deviations from a straight path already mentioned. In cutting its way through the Amrabad plateau composed of rocks of the Cuddapah system, the river passes through a great gorge about one hundred miles long.

The three rivers Godavari, Krishna and Pennar have built up in the course of ages an extensive coastal area of deposited material

extending all the way from Kakinada to Nellore. This area which is shown in the geological maps as a recent formation exhibits a curious feature in the shape of a tongue with lateral extensions protruding towards the interior behind Vijayawada and with the river Krishna flowing through it. This feature has evidently resulted as a consequence of the flow of the Krishna towards the sea being arrested by the presence of high ground in the shape of rock formations of the Khondalite series. It is in the material thus deposited by the river before it passes Vijayawada that the diamonds carried down by it were sought for and found in past years. The first volume of the *Journal of the Hyderabad Geological Survey* published in the year 1929 contains a compilation of all available information on the ancient diamond mines in the area. The maps appearing in this publication indicate the locations not far from the present course of the Krishna river where the diamonds were taken out. All of them were on the northern side of the river, viz., Partial, Atkur, Munnaluru, Mogaluru, Koduvat-kallu and Ustapalli, with one very significant exception, viz., Kollur. This last was on the right bank of the river where it takes a sharp turn to the north-east by reason of the presence of a range of hills blocking its flow eastwards. Kollur appears to have been a highly productive locality. It was visited by Tavernier who described the surface workings and stated that some 60,000 people were engaged in the mining operations at the time of his visit.

An intensive and prolonged exploration of any particular locality for diamonds might be expected to result in its ceasing to be productive, sooner or later. This is indeed the actual situation, and the fabulous wealth these mines produced is now only a memory. It is of course possible that several less promising locations were left unexplored, and it is also possible that methods of mining which go down to deeper levels might produce results. An inspection of the maps suggests that the course of the river Krishna above Vijayawada has shifted progressively southwards as the result of the deposition of the material which it brought down, and hence the exploration of areas further removed from its present course, and especially of the areas silted over by the streams flowing into it laterally might conceivably prove to be profitable. But the chief interest attaching to the subject of the diamonds found in the past in the Krishna valley

is in the problem of locating the original source of these diamonds and of exploiting these original sources to the fullest practicable extent.

The long and tortuous course pursued by the river between Sangameswaram and Vijayawada lies for the most part in what are recognised geologically as the upper Cuddapah formations, and only a small part of the same lies within the formations of lesser age known as the Kurnools. The actual facts of the case suggest that the diamonds deposited in the lower reaches of the river were a part (and naturally only a very small part) of the material scooped out by the flood waters from the floor and walls of the gorges excavated by them and deposited where the flow was arrested. Whether this action was confined to any particular stretch or stretches of the length of the river or whether it extended over the whole or a greater part of its entire course can only be surmised and must await determination by a careful examination of the exposed areas of the river gorges.

It should be emphasised that the Krishna valley lies much further north than the areas bounded on the west by Lattavaram and Guntakkal, and on the east by Dhone and Gooty and including especially the well-known locality of Vajrakarur, where there were diamond workings in the sixteenth and seventeenth centuries. The geological maps show that the areas mentioned lie outside the Cuddapah formations, and there is therefore no reason for assuming that the circumstances which led to diamonds being found in these areas at or near the surface of the earth have any bearing on the problem of the original source of the diamonds found in the Krishna valley. Further, in view of the great age of the Cuddapah formations and the absence of any evidence of volcanic activity in the regions traversed by the Krishna river, there is nothing to suggest that the diamonds in the valley were thrown up and made accessible to erosion by the flow of the river by any such activity in the ages subsequent to the laying down of those formations.

The whole purpose of this article is to indicate that the history of diamonds in the Krishna valley need not be treated as a closed chapter having only a historic interest, and that on the other hand, it may well prove to be a subject of practical importance at the present time if pursued vigorously but with the necessary circumspection.

## THERMAL EXPANSION OF TUNGSTEN MONOCARBIDE

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## INTRODUCTION

**T**UNGSTEN Monocarbide (WC) is an interstitial compound and has a simple hexagonal structure.<sup>1-4</sup> Like most other interstitial compounds, it is a technologically important and structurally interesting substance. It combines in its physical behaviour the characteristic metallic property of decreasing electronic conductivity with increasing temperature with typical covalent peculiarities like hardness and brittleness.<sup>5</sup> This strange combination of properties is due to an interplay of non-directional metallic bonds between tungsten atoms and the directed covalent bonds between tungsten and carbon atoms.<sup>6</sup> These features of the WC structure are also likely to be reflected in other physical properties, particularly in the anisotropy of its mechanical behaviour and thermal expansion. Not much work appears to have been done on the directional dependence of the mechanical properties, probably because of the difficulty of obtaining suitable single crystals. There is only one report available showing that WC exhibits anisotropy in its microhardness.<sup>7</sup> Its elastic anisotropy has recently been estimated from measurements on X-ray line broadening and displacement by Ivensen *et al.*<sup>8</sup> The directional thermal expansion has been investigated by Becker<sup>9</sup> and Belikov and Umanskii.<sup>10</sup> Although in both these reports the nature of anisotropy in thermal expansion is similar, there are large differences in the magnitudes of the principal coefficients and also in the amount of the anisotropy (Table II). Further, as discussed later in this paper, the nature of the anisotropy reported by these workers does not appear to be in accord with either the nature of bonding involved in the structure<sup>6</sup> or the elastic anisotropy reported by Ivensen *et al.*<sup>8</sup> Hence a fresh and systematic study of the temperature variation of the lattice parameters of the crystal over a restricted range of temperature, was undertaken by the authors.

## EXPERIMENTAL AND RESULTS

X-ray powder pictures of tungsten monocarbide at different temperatures were taken

employing a high temperature symmetrical focusing camera<sup>11</sup> and CuK $\alpha$  radiation. The reflections measured and used in calculations

were  $(30\bar{3}0)_{a_1a_2}$ ,  $(30\bar{3}1)_{a_1a_2}$ ,  $(11\bar{2}3)_{a_1}$  and  $(21\bar{3}2)_{a_1a_2}$ . The lattice parameters were

evaluated by using Cohen's<sup>12</sup> method in combination with the error function  $\phi \tan \phi$ . Standard errors in the values of the parameters were evaluated by the method of Jette and Foote.<sup>13</sup>

Table I gives the values of the lattice parameters along with the estimated errors and the

TABLE I  
Lattice parameters and axial ratio of WC  
at different temperatures

Temp. °C.	$a$ Å	$c$ Å	$c/a$
25	2.9064 $\pm 0.003$	2.8374 $\pm 0.003$	0.9762
82	2.9071 $\pm 0.003$	2.8377 $\pm 0.003$	0.9761
164	2.9083 $\pm 0.004$	2.8385 $\pm 0.003$	0.9760
218	2.9088 $\pm 0.002$	2.8390 $\pm 0.002$	0.9760
280	2.9091 $\pm 0.004$	2.8396 $\pm 0.003$	0.9760

axial ratio at different temperatures. Since both the parameters showed a linear temperature dependence, the data were processed by the usual method of curve fitting and the following expressions were obtained.

$$\begin{aligned} a_t &= 2.90627 + 110.13 \times 10^{-6} t \\ c_t &= 2.83709 + 87.18 \times 10^{-6} t \end{aligned}$$

Here  $a_t$  and  $c_t$  are expressed in Å and  $t$  in °C. The two temperature independent coefficients of expansion were derived from these expressions and are given in Table II, the values from earlier workers being also given for comparison.

TABLE II  
Comparison of the thermal expansion  
coefficients of tungsten monocarbide

Authors	$\alpha_a \times 10^6 / ^\circ\text{C.}$	$\alpha_c \times 10^6 / ^\circ\text{C.}$
Becker <sup>9</sup>	..	5.2
Belikov & Umanskii <sup>10</sup>	..	3.84
Present work	..	3.78
		3.07

A comparison of the present values of the lattice parameters with those available in literature is also given in Table III.

TABLE III  
Comparison of the lattice parameters of WC  
at room temperature

Author	$a$ Å	$c$ Å	Composition
Metcalf (1946) <sup>14</sup>	2.9063	2.8386	WC <sub>1.0</sub>
Nowotny & Kieffer (1947) <sup>15</sup>	2.9028	2.833	..
Krainer & Konopicky (1947) <sup>16</sup>	2.9066	2.8364	..
Krainer (1950) <sup>17</sup>	2.9066	2.8367	..
Leciejewicz (1961) <sup>3</sup>	2.9065	2.8361	..
Levinson (1964) <sup>18</sup>	2.9084	2.8370	WC <sub>0.99</sub>
Brown <i>et al.</i> (1966) <sup>19</sup>	2.9066	2.8374	WC <sub>1.007</sub>
Present work	2.9064	2.8374	*WC <sub>0.99</sub> to WC <sub>1.00</sub>

\* Estimated from a comparison of the present lattice parameters with those for well-characterised samples from other sources.<sup>20(a)</sup>

#### DISCUSSION

The agreement between the present values of the parameters and the others given in Table III, is generally satisfactory, particularly the recent values by Brown *et al.*<sup>19</sup> The data on coefficients of expansion given in Table II show that while the old values given by Becker<sup>9</sup> for both the coefficients are rather high, there is some agreement between the present values and those given by Belikov and Umanskii.<sup>10</sup> However, there is a significant difference worth noting. Belikov and Umanskii report a value of  $\alpha_c$  slightly larger than that of  $\alpha_a$ , although the difference is not appreciable. The present results differ from this in two respects; firstly the difference between the two coefficients is relatively large and secondly the value of  $\alpha_c$  is smaller than that of  $\alpha_a$ . Although, it may be argued that much significance cannot be attached to the small differences involved in the above comparison, the plausibility of the present results can be judged from the following reasoning.

The estimates given by Ivensen *et al.*<sup>8</sup> on the elastic anisotropy of WC indicate that the elastic modulus along  $c$ -axis is 1.5 times larger than that along a perpendicular direction. This means that in a general way, the binding of the atoms in the crystal is stronger along the  $c$ -axis than in the basal plane. Again, as Belikov and Umanskii<sup>10</sup> have pointed out, the fact that the axial ratio is less than unity indicates that the structure is compressed along

the hexagonal axis, which obviously is a manifestation of stronger binding along this direction. Further, W-W metallic bond distances in the basal planes are 2.906 Å. As against this, the W-W distances along  $c$ -axis are 2.837 Å. These distances are larger than the W-W distances in tungsten metal by 6.3% and 3.8% respectively. As Rundle<sup>6</sup> pointed out, this lengthening is an indication of the weakening of metallic bond by the introduction of carbon atoms in the structure and so it may be said that in WC, the metal-metal bonds are relatively stronger along the hexagonal axis, when compared to those in the basal plane. The bonding between tungsten and carbon atoms in the structure is covalent and these directed bonds make angles of about 50° with the  $c$ -axis. Although this would mean that the components of these bond vectors along the  $c$ -axis are slightly larger than those in the perpendicular directions, yet these bonds are not very strong as evidenced by the lower melting points of the carbide (2710–2780°C.), when compared to that of the metal (3410°C.).<sup>10(b)</sup> Therefore effectively the two components could be considered to be not very much different from each other. In other carbides (e.g., TiC, ZrC, HfC and VC, etc.) where the carbon atoms are octahedrally bonded to metal atoms and the covalent bonds are very strong, the carbides have higher melting points than those of the corresponding metals.<sup>20(b)</sup>

It is worth mentioning here that Belikov and Umanskii who have reported the results on many carbides, calculated the principal coefficients of thermal expansion "from the displacements of the interference maxima for various orientations of the crystallographic planes perpendicular (or nearly perpendicular) to the  $a$  and  $c$  axes", and it is not clear from their paper, as to which reflections they used in the case of tungsten monocarbide. In view of the above arguments, it is reasonable to conclude that in WC, the thermal expansion along  $a$ -axis is more than that along  $c$ -axis.

#### ACKNOWLEDGEMENTS

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1. Westgren, A. and Phragmen, G., *Z. Anorg. Chem.*, 1926, **156**, 27.
2. Plau, H. and Rix, W., *Z. Metallk.*, 1954, **45**, 116.
3. Lecięwicz, L., *Acta Cryst.*, 1961, **14**, 200.
4. Butorina, I. N., *Kristallografiya*, 1960, **5**, 233.
5. Wells, A. F., *Structural Inorganic Chemistry*, The Clarendon Press, Oxford, 1960, p. 1017.
6. Rundle, R. E., *Acta Cryst.*, 1948, **1**, 180.
7. French, D. N. and Thomas, D. A., *Trans. Metal. Soc. AIME*, 1965, **233**, 5, 950.
8. Ivenson, V. A., Koval'skii, A. E., Semenovskaya, S. V. and Pibile, O. N., *Phys. Metals Metallography (GB)*, 1962, **12**, 2, 126.
9. Becker, K., *Z. Phys.*, 1928, **51**, 481.
10. Belikov, A. M. and Umanskii, Ya. S., *Soviet Phys. Cryst.*, 1960, **4**, 643.
11. Sirdeshmukh, D. B., *Ph.D. Thesis*, Osmania University, 1963.
12. Cohen, M. U., *Rev. Sci. Instr.*, 1935, **6**, 68.
13. Jette, E. R. and Foote, F., *J. Chem. Phys.*, 1935, **3**, 606.
14. Metcalfe, A. G., *J. Inst. Metals*, 1946, **73**, 591.
15. Nowotny, H. and Kieffer, R., *Metallforschung*, 1947, **2**, 257.
16. Kramer, H. and Konopicky, K., *Bergund Huttenm. Monatsheft*, 1947, **92**, 166.
17. —, *Arch. Eisen Huttenm.*, 1950, **21**, 119.
18. Levinson, L. S., *J. Chem. Phys.*, 1964, **40**, 1437.
19. Brown, Harry, L., Armstrong, Philip, E. and Kempter, Charles, P., *Ibid.*, 1965, **45**, 547.
20. (a) Storms, Edmund, K., *The Refractory Carbides*, Academic Press, New York, 1967, **2**, 147.  
(b) —, *Ibid.*, Academic Press, New York, 1967, **2**, 228.

## THE GLOBAL ATMOSPHERIC RESEARCH PROGRAMME (GARP)

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THE International Union for Geodesy and Geophysics created a Committee on Atmospheric Sciences (CAS) and requested it "to develop an expanded programme of atmospheric science research". The CAS was created in June 1964 to advise the International Council of Scientific Unions on matters arising from the following two UN resolutions:

Resolution 1721 (XVI) December 1961, which recommended "members and WMO to study measures to advance the state of atmospheric sciences and technology in order to improve existing weather forecasting capabilities and to further the study of the basic physical processes that effect climate" and Resolution 1802 (XVII) December 1962, which recommended that WMO "develop in greater detail its plan for an expanded programme to strengthen meteorological services and research", and invited ICSU through its unions and national academies "to develop an expanded programme of atmospheric science research which will complement the programmes fostered by the World Meteorological Organization".

Since 1962, a major effort to respond to the two UN resolutions has been made by the WMO resulting in the formulation of the

World Weather Watch (WWW) Programme. The last WMO Congress which met in Geneva in April 1967 approved detailed plans for the further developments of the weather observing networks maintained by member nations.

In recent years rather remarkable progress had been made in formulating physico-mathematical models of the atmosphere, treated as a fluid dynamical system, and in using powerful computers to integrate the governing thermohydrodynamic equations to stimulate and forecast the behaviour of the atmosphere. In parallel with this, the development of the meteorological satellite has introduced a dramatic new observational capability. Several countries in middle latitudes now produce objective numerical forecasts of the evolution of weather systems over periods of 2-3 days and these are rapidly superseding traditional methods of forecasting the main features of the pressure, temperature and wind fields, at least in middle latitudes. Using very complex models of the global atmospheric circulation, it has been possible to simulate the major features of the world's climate and to conduct numerical experiments which strongly indicate that it should be possible to produce reliable forecasts of the major features of the weather for about one week ahead.

But this cannot be realized without an adequate coverage of meteorological observations over the whole globe including oceanic and tropical regions. The World Meteorological Organization is already operating an observational system but it is at present inadequate in coverage and performance for the above purpose. An improved system, the World Weather Watch, is being evolved to meet this requirement. It is based on a global observation system, including satellite observations, a global telecommunications system, and a global data-processing system based on a number of world and regional centres that will, in general, use powerful computers to process the observational data and produce numerical weather analyses and forecasts on the global regional scales.

However, in order to produce reliable forecasts for more than 2-3 days ahead, it will be necessary to improve our understanding of a number of atmospheric processes that determine the evolution of weather on the time scale of a week or more and to incorporate these processes more realistically into the numerical models. It is well known that large-scale atmospheric processes are significantly affected by cumulus convections particularly over the tropics. A satisfactory method of parameterising this effect in numerical weather prediction models has yet to be developed. Also, a great deal of investigation will be required to establish the optimum observational network to meet these requirements. The formulation of realistic physical models of the atmosphere and the optimum design of the observation system are the main objectives of the *Global Atmospheric Research Programme (GARP)*, which is a joint programme of WMO and ICSU.

The programme's ultimate goal is to provide a *scientifically sound physical basis for long-range weather prediction*. The GARP effort is not an operational programme but a research effort which will involve many atmospheric scientists and technologists from government services and laboratories, universities and industry, from many countries. The planning of this activity is being co-ordinated by a Joint Organisation Committee

of twelve Scientists, of which Prof. P. R. Pisharoty is the scientist from India. As the promise of GARP is completed and demonstrated, appropriate modifications and extensions will be incorporated into the operational part of the WWW as needed and funded.

The operational part of the World Weather Watch, at present and its expected structure in the future, is the responsibility of the nations of the world which operate it through the World Meteorological Organisation.

The Global Atmospheric Research Programme (GARP) is thus a programme for studying those physical processes in the troposphere and stratosphere that are essential for an understanding of:

- (a) The transient behaviour of the atmosphere as manifested in the large-scale fluctuations which control changes of the weather; this would lead to increasing the accuracy of forecasting over periods from one day to several weeks.
- (b) The factors that determine the statistical properties of the general circulation of the atmosphere which would lead to better understanding of the physical basis of climate.

This programme consists of two distinct parts, which are, however, closely interrelated:

- (1) The design and testing by computational methods of a series of theoretical models of relevant aspects of the atmosphere's behaviour to permit an increasingly precise description of the significant physical processes including small-scale tropical cumulus convection and their interactions.
- (2) Observational and experimental studies of the atmosphere to provide the data required for the design of such theoretical models and the testing of their validity.

The global experiment is now planned for the year 1975 or 1976. The special committee jointly set up by the World Meteorological Organisation and the International Council for Scientific Unions is working on the plan.



## HETEROGENEITY IN THE FIBRE COMPOSITION OF THE FLIGHT MUSCLES OF DRAGONFLIES (ODONATA)

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I HAVE read the letter, "Occurrence of giant muscle fibres in the flight muscle of *Pantala flavescens*" by Bhat<sup>1</sup> which appeared recently in *Current Science*, with the interest it deserves. The work reported was carried out under my direction in my former laboratory at Baroda, India, during his tenure as a research student. It is unfortunate that he chose to get it published without my knowledge. In doing so, he has presented wrong and misleading interpretations of the observations made. I should therefore like to present to your readers a discussion on the problem of heterogeneity in the fibre composition of the flight muscles of dragonflies.

Bhat<sup>1</sup> reports the occurrence in the dragonfly flight muscle some "giant fibres" ranging in diameter from 40 to 70  $\mu$  among the more numerous "normal fibres" of 20–30  $\mu$  in diameter. In explaining the origin of these so-called "giant fibres" he states thus: "Muscle hypertrophy generally results from continuous and prolonged exercise of the organ to cope up with high energy demand. *Pantala flavescens* is an efficient flier and remains in the air for long periods while swarming, thus giving continuous exercise to its flight muscle. This could probably account for the presence of giant fibres in some species while they are absent in other species of dragonflies."

At the outset, it must be said that it is incorrect and misleading to call these large fibres "giant fibres" and regard them as abnormal or hypertrophied. They are distinctly different from the classical giant fibres that constitute the fibrillar (asynchronous) type of flight muscle of Diptera, which may be, for instance, as large as 1800  $\mu$  in diameter (e.g., *Rutilla polina*).<sup>2</sup> The dragonfly flight muscle, on the other hand, is of the primitive tubular (synchronous) type. If the large fibres in the flight muscle of *Pantala flavescens* did really originate as a result of muscular hypertrophy due to continuous exercise, then, all the fibres in the muscle should be large and should occur only in the actively flying adult. But these fibres are considerably fewer in number

than the small fibres and we have no information as to exactly when they get differentiated. In this context, it should be mentioned that two types of fibre, Type 1: red, narrow (30  $\mu$  in diameter) and Type 2: white, broad (70  $\mu$  in diameter) of the pigeon pectoralis muscle, are known to be already differentiated *in ovo* and not during the process of the young attaining the ability to fly.<sup>3,4</sup> The occurrence of the two types of fibre is therefore to be regarded as a case of cellular specialization which may reflect hypertrophy of certain structures within the cell which are less evident in other cells and also represent different metabolic and functional adaptations.

The fibrillar (asynchronous) type flight muscle occurring in Hymenoptera, Hemiptera (except Cicadidae), Ephemeroptera, Tysanoptera, Coleoptera and Diptera, has been characterized structurally as one consisting of relatively large fibres with the mitochondria (sarcosomes) distributed in between the myofibrils, the extensive invagination of the tracheoles into the fibre and a marked reduction of the endoplasmic reticulum (SR system). The primitive synchronous type found in the Orthoptera, Lepidoptera, Odonata and Hemiptera (Cicadidae) is distinctly different from the asynchronous one in that the SR system is well developed. However, a certain extent of tracheolar penetration may occur in the flight muscles of some Orthoptera and Lepidoptera as also large mitochondria are present in the flight muscles of the Odonata.<sup>5-10</sup>

Functionally, insects with lower rates of wing beat possess synchronous flight muscles. For instance the swallow butterfly has a wing beat of 5 per second and the dragonfly 35 per second. These frequencies tally with the range of performance of vertebrate skeletal muscles. Insects with asynchronous flight muscles, on the other hand, have wing beats ranging from 55 to as many as 1046 per second.<sup>9</sup>

In correlating structure with function, it may be suggested that the special features such

small fibre diameter, presence of well-developed SR system and large mitochondria are conducive to low-frequency wing beat as well as sustained flight. On the other hand, features such as large fibre diameter, presence of well-developed tracheolar system and large mitochondria as they occur in bees, are favourable for high frequency wing beat for considerable length of time. In the evolution of insect flight muscles, it is clear that, either the diameter of the fibres has to be drastically reduced or the indenting tracheoles have to be increased. According to Weis-Fogh the fibre diameter cannot exceed about  $20\mu$  unless the tracheoles indent the surface and become internal.<sup>10</sup> In the Odonata and the Blattidae where the fibres are supplied with tracheoles "only from the surface," the radiating lamellar arrangements of fibrils, with the intervening large mitochondria, are an adaptation for enhancing diffusion of oxygen inside the fibre.<sup>11</sup> It would be of interest to know if the tracheoles do penetrate the large fibres of the flight muscle of *Pantala flavescens*. If they do not, which is probably the case, it means that there is less diffusion of oxygen inside the large fibres. It has been shown that the flight muscles of *Pantala flavescens* have a high level of lipase activity, about six times that of the flight muscles of the locust.<sup>12</sup> It is also known that the locust utilizes fat as the chief fuel during flight.<sup>13</sup> The significance of high concentrations of lipase in muscles sustaining sustained activity and utilizing fat as the chief fuel, has been revealed.<sup>14</sup> The red, fat-utilizing fibres in such muscles of vertebrates are known to contain high concentrations of fat and oxidative enzymes and to be adapted for an aerobic metabolism unlike the white glycogen-utilizing ones which are adapted for anaerobic metabolism.<sup>4</sup> The fact that the large fibres in the flight muscles of *Pantala flavescens* contain less fat and probably lower concentrations of lipase and oxidative enzymes than the small fibres, suggest that these large fibres have a lower capacity for aerobic metabolism. In this context the observations of Ogata and Mori<sup>15</sup> on the flight muscles of the Japanese dragonfly (*Anotogaster sieboldii*) are of special interest. They found two types of fibre which they compared with the red and white fibres of the vertebrate skeletal muscle. The former was found to contain considerably higher concentrations of the several oxidative enzymes studied than the latter. However, these authors have not men-

tioned the diameter of the two fibre types. Nevertheless, from their photomicrographs the Type 2 fibres which line the periphery of the fasciculus seem to be slightly larger than the inner ones. Similarly, the peripheral fibres in a muscle lobe of the flight muscle of another dragonfly, *Aeshna* spp. also seem to be larger than the inner ones (Weis-Fogh, Fig. 4).<sup>11</sup> In the pigeon pectoralis muscle too, the Type 2 (white) fibres line the periphery of the fasciculi. In the flight muscle of *Pantala flavescens*, however, the large fibres are not confined to the periphery and they range from  $40-70\mu$  in diameter. So at least with respect to diameter, some of them seem to be intermediate like the intermediate type of fibre seen in vertebrate skeletal muscles.<sup>4-16</sup> One important difference between the Type 2 fibres of vertebrate skeletal muscle and that of the dragonfly flight muscle, is that the mitochondria in the latter are considerably larger than those in the Type 1 fibres of the same muscle. This is so because the insect muscle, with the acquisition of the tracheolar system, is better adapted for an aerobic metabolism.

It is known that the flight muscles of flying insects contain very high concentration of  $\alpha$ -glycerophosphate dehydrogenase and no lactic dehydrogenase whereas the leg muscles of some insects (e.g., *Locusta* and *Belostoma*) contain equally high concentrations of the latter enzyme and of not the former.<sup>17-19</sup> It is therefore clear that there are two different mechanisms operating in insect muscles. In the light of this, we may speculate that the large fibres in the flight muscle of *Pantala flavescens* and probably the peripheral fibres in the flight muscles of other dragonflies too, contain the same mechanism involving the reduction of pyruvate to lactate, as in the leg muscle of the locust or for that matter in the white fibres of the pigeon breast muscle. This would mean that the larger, Type 2 fibres in the dragonfly flight muscle should have a higher concentration of lactic dehydrogenase. But Ogata and Mori<sup>15</sup> in their histochemical preparations observed a lower activity of this enzyme in these fibres. It should be pointed out here that by the method employed by them for the demonstration of lactic dehydrogenase activity, a higher enzyme activity would be obtained where there is higher diaphorase activity. In the pigeon pectoralis muscle too similar observations were made in earlier studies. Later works have shown that there is, indeed, higher activity of this enzyme in the

Type 2 fibres of the vertebrate skeletal muscles.<sup>20</sup> Similar histochemical studies on the flight muscles of dragonflies should be revealing.

From the available information on the flight muscles of dragonflies, two diverse types may be distinguished: one as in *Aeshna* spp. and the other as in *Pantala flavescens*. These two types represent two lines of evolution. In an extensive study of the pectoralis muscle in birds and bats, certain parallel lines of evolution have been traced.<sup>4,21</sup> If the fibre composition of the two types of flight muscles in dragonflies is compared with that of the bird and bat pectoralis muscles, the muscles of *Pantala flavescens* in having the large Type 2 fibres and small Type 1 fibres, tally with the pectoralis of the pigeon and that of the bat, *Hipposideros*. The flight muscles of *Aeshna* spp. and *Anotogaster sieboldi* correspond to the pectoralis of the sparrow and the bat, *Pipistrellus* in which there are only Type 1 fibres. In the muscles of these two dragonflies, however, the peripheral fibers in a fasciculus tend to be slightly larger and also contain lower levels of oxidative enzymes<sup>15</sup> (except lactic dehydrogenase?) than the inner fibres. In the pectoralis muscle of the sparrow, though no difference in the size of the fibres has been noted, the peripheral region was shown to be different from the inner region at the biochemical level. This region was found to have a higher level of glycolytic metabolism.<sup>22</sup> An extensive survey of the flight muscles of dragonflies may well reveal more patterns in their cellular organization.

Structure is the complement of function. In the vertebrate muscle, the ability for fast contractions of short duration is attributed to the Type 2 fibres (phasic) and that for slower and sustained contractions to the Type 1 fibres (tonic).<sup>4</sup> In the light of this, it may be suggested that the occurrence of Type 2 fibres amidst the Type 1 in the same muscle, as seen in *Pantala flavescens*, is a case of structural and functional adaptation for manoeuvrable flight. Dragonflies indulge in hovering flight,

and the housefly and the honey-bee in manoeuvrable flight." It could therefore be argued that *Pantala flavescens* in having the Type 2 fibres in their flight muscles is capable of a certain amount of manoeuvrability in flight.

Finally, if the present discussion has brought to light the complexity of the problem of cellular heterogeneity in the organization of insect flight muscles and the possibilities for further investigation, it has served its purpose.

1. Bhat, Krishna Murthy, U., *Curr. Sci.*, 1968, **37**, 207.
2. Tiegs, O. W., *Phil. Trans.*, 1955, **238 B**, 221.
3. Chinoy, N. J. and Georger, J. C., *J. Anim. Morphol. Physiol.*, 1965, **12**, 57.
4. George, J. C. and Berger, A. J., *Avian Myology*, Academic Press, New York, 1966, p. 68.
5. Pringle, J. W. S., *Insect Flight*, Cambridge Univ. Press, London, 1957.
6. —, "Locomotion-Flight," *The Physiology of Insecta*, Ed. M. Rockstein, Academic Press, New York, 1965, 2.
7. Smith, D. S., *J. Biophys. Biochem. Cytol.*, 1961, **2**, 119.
8. —, *Rev. Canad. Biol.*, 1962, **21**, 279.
9. —, *Sci. Amer.*, 1965, **212**, 76.
10. —, *J. Cell. Biol.*, 1966, **28**, 109.
11. Weis-Fogh, T., *J. Exp. Biol.*, 1964, **41**, 229.
12. George, J. C., Vallyathan, N. V. and Scaria, K. S., *Experientia*, 1958, **14**, 250.
13. Weis-Fogh, T., *Phil. Trans.*, 1952, **237 B**, 1.
14. George, J. C., *J. Anim. Morphol. Physiol.*, 1964, **11**, 233.
15. Ogata, Takuro and Mori, Masahiko, *J. Histochem. Cytochem.*, 1964, **12**, 183.
16. Stein, J. M. and Padykula, H. A., *Am. J. Anat.*, 1962, **110**, 103.
17. Zebé, E. C. and McShan, W. H., *J. Gen. Physiol.*, 1957, **40**, 779.
18. Sacktor, B., "Energetics and respiratory metabolism of muscular contraction," In *The Physiology of Insecta*, Ed. M. Rockstein, Academic Press, New York, 1965, 2.
19. Chefurka, W., "Intermediary metabolism of carbohydrates in insects," *Ibid.*
20. George, J. C., Susheela, A. K. and Vallyathan, N. V., *J. Anim. Morphol. Physiol.*, 1963, **10**, 24.
21. —, *Pavo. (Ind. J. Ornithol.)*, 1965, **3**, 131.
22. —, Susheela, A. K. and Vallyathan, N. V., *Ibid.*, 1964, **2**, 115.

## LETTERS TO THE EDITOR

STUDY OF THE RADIOACTIVITY OF  
SEPARATED MINERALS OF BEACH  
SANDS OF MANAVALAKURICHI,  
MADRAS STATE

THE beach sands of Manavalakurichi, Madras State, contain essentially the minerals ilmenite, rutile, zircon, monazite, garnet, sillimanite, quartz and a few others in small percentages. In the present work, the distribution of radioactivity in some of these minerals in the various particle sizes, occurring naturally, has been carried out using a scintillation counter with RCA 6199 photomultiplier and activated zinc sulphide as phosphor. The samples analysed, with their purities indicated within the brackets, are:

Monazite (98.4%); Zircon (98.34%, containing 33.17%  $\text{SiO}_2$ ); Garnet (98.84%); Ilmenite (97.43%); Rutile (96.0%).

Zircon and monazite have been separated into six natural fractions and the percentage abundance of various sizes in these minerals shows a close agreement. All the samples indexed in the present work are crushed to the same size and passed through 40 microns size sieves. The index is accurate to  $\pm 2\%$ .

TABLE I

Size fractions (in microns)	Monazite		Zircon	
	Percentage of sample	Alpha-index (alphas/mg./hr.)	Percentage of sample	Alpha-index (alphas/mg./hr.)
Total sample	100	$12.3 \times 10^3$	100	104
$\geq 315$	0.5	$12.0 \times 10^3$	0.3	169
315-250	2.7	$12.0 \times 10^3$	2.5	176
250-160	56.8	$13.1 \times 10^3$	66.3	171
160-125	24.6	$10.8 \times 10^3$	21.4	222
125-90	14.1	$11.7 \times 10^3$	8.9	312
$< 90$	1.3	$12.3 \times 10^3$	0.6	438

Alpha-index (alphas/mg./hr.)

Garnet	31
Rutile	118
Ilmenite	29

From the data, it is clear that the alpha-index is not the same for all the size fractions of either monazite or zircon. It may be due to variations in the contents of uranium or thorium in the form of loss or gain in certain size fractions. Also, it is likely that these

placer deposits are made up of a mixture of different types, weathered from pegmatites of different zones as originally suggested by Holmes<sup>1</sup> and the lead-alpha studies of Sivaramakrishnan and Venkatasubramanian.<sup>2</sup> To confirm this, the age determinations of these separated materials are being done by Lead-Alpha and Alpha-Helium methods.

Our thanks are due to M/s. Indian Rare Earths Ltd., Quilon, who have kindly supplied us the samples, analysed for their purity, mentioned in this work.

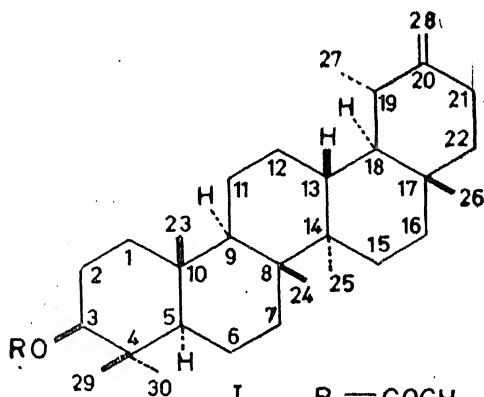
Department of Physics, C. S. SASTRI.  
Indian Institute of Technology,  
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Madras, July 8, 1968.

1. Holmes, A., *Proc. Geol. Ass. Canada*, 1955, 7, 81.
2. Sivaramakrishnan, V. and Venkatasubramanian, V. S., *Proc. Nat. Inst. Sci., India*, 1959, 25A, 278.

ISOLATION OF TARAXASTEROL  
AND ITS ACETATE FROM THE  
LEAVES OF COSTUS,  
SAUSSUREA LAPPA CLARKE\*

ISOLATION of  $\beta$ -sitosterol, stigmasterol and betulin from the solvent extracted costus root oil has long ago been reported.<sup>1</sup> Leaves of the plant have not been critically examined so far, though the isolation of an alkaloid 'saussurin' has been reported from them.<sup>2</sup> Extraction of the dried and powdered leaves (along with stalks) with hexane, furnished a dark green concentrate (3.4% yield). This, on chromatography over alumina, furnished solids in the hexane, hexane-benzene (1:1) and benzene eluates. The solid from the hexane eluate, on repeated crystallisation from ethyl acetate, hexane-ethyl acetate followed by acetone melted at 246-248°, ( $n_D^{20} + 100$ ) (chloroform), mol. wt. 468 (mass spectrum), elemental analysis  $\text{C}_{32}\text{H}_{52}\text{O}_2$  requires: C, 81.75; H, 11.05;  $\text{C}_{32}\text{H}_{52}\text{O}_2$  requires: C, 81.99; H, 11.18%. Its IR spectrum shows bands at 1724 ( $\text{C}=\text{O}$ ), 1251  $\text{cm}^{-1}$  (acetate); 1634, 889  $\text{cm}^{-1}$  ( $\text{C}=\text{CH}_2$ ). The NMR spectrum shows signals at 9.27, 9.13, 9.09, 8.97, 8.95  $\tau$  [21 H; methyls at  $\text{C}_4$ ,  $\text{C}_8$ ,  $\text{C}_{10}$ ,  $\text{C}_{14}$ ,  $\text{C}_{17}$  and

C<sub>19</sub> in structure (I)]; 8.05  $\tau$  (3 H, acetate methyl at C<sub>3</sub>) and a broad doublet centred at 5.4  $\tau$  (2 H; olefinic protons at C<sub>28</sub>).



I, R = COCH<sub>3</sub>

II R = H

The IR and NMR spectra were superimposable on those of an authentic sample† of taraxasteryl acetate. Mixed melting point determination with an authentic sample of taraxasteryl acetate, m.p. 248°, showed no depression [Literature<sup>3</sup> records for pure taraxasteryl acetate m.p., 256–257°, ( $\alpha$ )<sub>D</sub> + 100° (benzene)]. Repeated crystallisation of our samples did not raise the m.p. appreciably. The acetate on LAH reduction affords the alcohol (II) which on purification by crystallisation from hexane-ethyl acetate followed by acetone melted at 222°, ( $\alpha$ )<sub>D</sub> + 90°, mol. wt. 426 (mass spectrum), elemental analysis C<sub>30</sub>H<sub>50</sub>O (Found C, 83.95; H, 11.92; C<sub>30</sub>H<sub>50</sub>O requires: C, 84.44; H, 11.81%). Its IR spectrum showed peaks at 3390, 1042 cm.<sup>-1</sup> (OH) and 1639, 889 cm.<sup>-1</sup> (C=CH<sub>2</sub>). The NMR spectrum showed signals at 9.27, 9.15, 9.07, 8.97, 8.96  $\tau$  (21 H; methyls at C<sub>1</sub>, C<sub>8</sub>, C<sub>10</sub>, C<sub>14</sub> and C<sub>19</sub> and a doublet centred at 5.39  $\tau$  (2 H; olefinic protons at C<sub>28</sub>). The physical constants and spectral data are in agreement with those of taraxasterol. This is further confirmed by mixed melting point determination with an authentic sample†; m.p. 223°, which is undepressed. The solid from the benzene eluate was chromatographed on alumina and shown to consist of a mixture of taraxasteryl acetate m.p. 246° and taraxasterol m.p. 218°. These were identified by physical constants, spectral data and mixed melting point determination. Literature<sup>3</sup> records for pure taraxasterol m.p. 226–27°, ( $\alpha$ ) + 102° (benzene),

National Chemical  
Laboratory,  
Poona-8, June 8, 1968.

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G. H. KULKARNI,  
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\* Contribution No. 1198.

† We are thankful to Dr. Sukh Dev of this Laboratory for supplying samples of taraxasterol and its acetate isolated from *Calotropis gigantea* L.

1. Kulkarni, G. H., Rao, A. S., Kelkar, G. R. and Bhattacharyya, S. C., *Perf. and Ess. Oil Rec.*, 1961, **51**, 20.
2. Ghosh, S., Chatterjee, N. R. and Dutta, A., *J. Ind. Chem. Soc.*, 1929, **6**, 517.
3. Simonsen, J. L. and Ross, W. C. J., *The Terpenes*, (1957 Edn.), **4**, 159.

### CARBAMATE ESTERS OF 8-QUINOLINOLS

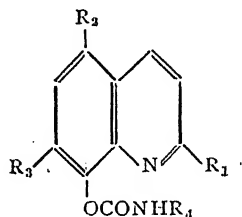
ESTERS of 5-chloro-, 5, 7-dichloro- and 5, 7-dibromo-8-hydroxyquinoline have been described<sup>1,2</sup> to possess increased antibacterial and antifungal properties in comparison with the corresponding 8-hydroxyquinolines. Carbamates,<sup>1,3</sup> nicotines,<sup>2</sup> benzoates<sup>4,5</sup> and acetates<sup>6</sup> of 8-hydroxyquinolines have all been claimed to possess interesting bactericidal and fungicidal properties.

As an extension to our work on 8-hydroxyquinoline derivatives,<sup>7</sup> we have prepared carbamate esters of 8-hydroxyquinoline, 5-chloro-8-hydroxyquinoline, 5, 7-dichloro-8-hydroxyquinoline, 8-hydroxyquinoline and 5, 7-dichloro-8-hydroxyquinoline. The compounds reported in this communication are listed in Table I. They have all been prepared by reacting the corresponding 8-hydroxyquinoline derivative with the appropriate isocyanate in dry benzene in presence of triethylamine or pyridine.

**8-Quinolyl-N-p-Chlorophenyl Carbamate.**—8-Hydroxyquinoline (4.35 g.; 0.03 mole) and *p*-chlorophenylisocyanate (5 g.; 0.033 mole) were refluxed for 4 hours in dry benzene (30 ml.) containing triethylamine (0.5 ml.). The reaction product was stripped of solvent; the solid residue was crystallised from benzene-hexane; m.p. 170–72°. Found: N, 9.32; Calc. for C<sub>10</sub>H<sub>11</sub>N<sub>2</sub>ClO<sub>2</sub>: N, 9.38%.

**8-(2-Methylquinolyl)-N-p-Anisyl Carbamate.**—8-Hydroxyquinoline (4.8 g.; 0.03 mole) and *p*-anisylisocyanate (5 g.; 0.033 mole) were refluxed for 4 hours in dry benzene (30 ml.) containing pyridine (0.5 ml.). The solvent was removed *in vacuo*; the residue was crystallised from benzene-hexane; m.p. 132–34° (Found: N, 9.27; Calc. for C<sub>19</sub>H<sub>19</sub>N<sub>2</sub>O<sub>3</sub>: N, 9.09%),

TABLE I



No.	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	R <sub>4</sub>	m.p. °C.*	Nitrogen %	
						Found	Calc.
1	H	H	H	C <sub>6</sub> H <sub>4</sub> Cl (4)	170-72	9.32	9.38
2	H	H	H	C <sub>6</sub> H <sub>4</sub> Cl (2)	118-20	9.51	9.38
3	H	H	H	C <sub>6</sub> H <sub>4</sub> Cl (3)	140-42	9.47	9.38
4	H	H	H	C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> (2)	143-45	13.22	13.59
5	H	H	H	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (4)	128-30	9.46	9.53
6	H	H	H	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (2)	103-05	9.66	9.53
7	H	H	H	C <sub>10</sub> H <sub>7</sub> (1)	110-12	8.78	8.92
8	H	Cl	H	C <sub>6</sub> H <sub>4</sub> Cl (4)	158-00	8.35	8.41
9	H	Cl	H	C <sub>6</sub> H <sub>4</sub> Cl (3)	143-45	8.20	8.41
10	H	Cl	H	C <sub>6</sub> H <sub>4</sub> Cl (2)	130-32	8.34	8.41
11	H	Cl	H	C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> (2)	133-35	12.05	12.23
12	H	Cl	H	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (2)	88-90	8.79	8.52
13	H	Cl	H	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (4)	142-44	8.68	8.52
14	H	Cl	H	C <sub>10</sub> H <sub>7</sub> (1)	108-10	7.87	8.04
15	H	Cl	Cl	C <sub>6</sub> H <sub>4</sub> Cl (4)	175-76	7.91	7.62
16	CH <sub>3</sub>	H	H	C <sub>6</sub> H <sub>4</sub> Cl (2)	88-90	8.63	8.96
17	CH <sub>3</sub>	H	H	C <sub>6</sub> H <sub>4</sub> Cl (3)	126-28	8.75	8.96
18	CH <sub>3</sub>	H	H	C <sub>6</sub> H <sub>4</sub> Cl (4)	150-52	9.02	8.96
19	CH <sub>3</sub>	H	H	C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> (2)	112-14	12.88	13.00
20	CH <sub>3</sub>	H	H	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (2)	93-95	8.90	9.09
21	CH <sub>3</sub>	H	H	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (4)	132-34	9.27	9.09
22	CH <sub>3</sub>	H	H	C <sub>10</sub> H <sub>7</sub> (1)	136-38	8.69	8.54
23	CH <sub>3</sub>	Cl	Cl	C <sub>6</sub> H <sub>4</sub> Cl (3)	124-26	7.24	7.34
24	CH <sub>3</sub>	Cl	Cl	C <sub>6</sub> H <sub>4</sub> Cl (4)	133-35	7.31	7.34
25	CH <sub>3</sub>	Cl	Cl	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (2)	122-24	7.57	7.43
26	CH <sub>3</sub>	Cl	Cl	C <sub>6</sub> H <sub>4</sub> OCH <sub>3</sub> (4)	124-26	7.69	7.43

\* All melting points are uncorrected.

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Wadi Wadi, D. M. DESAI.  
Baroda, July 26, 1968. S. L. MUKHERJEE.

1. Bate Institute, Ger. Pat. 11,93,945 (C.A., 1965, 63, 8327<sup>b</sup>).
2. Fiedler, H. and Raben, U., *Pharmazie*, 1966, 21, 233 (C.A., 1966, 65, 5891<sup>c</sup>).
3. Riedel-ce-Haen, A. G., Ger. Pat. 1,199,774; (C.A., 1965, 63, 18052<sup>c</sup>).
4. Griot, R., Renz, J., Bourquin, J. P. and Schenker, E. (to Sandoz Ltd.), U.S. Pat. 3,136,768 (C.A., 1964, 61, 6997<sup>b</sup>).
5. Chugai Pharmaceutical Co., Jap. Pat. 22,742 (C.A., 1966, 64, 8156<sup>b</sup>).
6. Sandoz Ltd., Brit. Pat. 977,334 (C.A., 1965, 62, 7736<sup>b</sup>).
7. Somasekhara, S., Dighe, V. S. and Mukherjee, S. L., *Curr. Sci.* (in press).

### INFLUENCE OF INTERMEDIARY METABOLITES ON BILE SECRETION

REPORTS on the role of intermediary metabolites in bile secretion are few. We reported that lactic acid augments bile secretion.<sup>1</sup> Glucose and fructose are reported to reduce bile secretion.<sup>2</sup> Chabrol and Maximin<sup>3</sup> observed increased bile flow on intravenous administration of oleic acid. Zuckerman *et al.*<sup>4</sup> also observed increase in flow of bile by oral administration of oleic acid. Although it has been suggested by Braur<sup>5</sup> that the energy for bile secretion is derived from the metabolic source, the exact nature of the source is still obscure.

### EXPERIMENTAL

Healthy adult dogs (6-8 kg.) of either sex were used in this study. The experimental

procedure for the collection of bile and analysis of bile constituents was described earlier.<sup>1</sup> One set of three dogs received no infusion. This set illustrated the influence of cannulation of bile duct on bile secretion. A second set of three dogs was given the intravenous infusion of normal saline and served as a control for dogs receiving acetoacetate (3-4 mg./min./kg.), pyruvate (4-5 mg./min./kg.), succinate (5-6 mg./min./kg.), citrate (4-5 mg./min./kg.), and lactate (6-7 mg./min./kg.).

For infusion, fatty acids were neutralized with NaOH and incubated for 10 min. prior to injection with equimolar amounts of bovine albumin.

### RESULTS

Table I compares the effect of these metabolites on the rate of excretion of bile and its constituents. It is seen that when albumin solution is infused alone there is the reduction of the bile secretion by about 11.9% and the excretion of bile acids by 23.3%, bilirubin by

13.6% and cholesterol by 33.3%. The effect of palmitate in albumin produces more or less similar effect, but the infusion of oleate in albumin increases the rate of secretion of bile and cholesterol by 2.8% and 68.7% respectively. The excretion of bile acids is more during the infusion of oleate as compared with albumin control, while that of bilirubin is not significantly altered. Acetoacetate reduces the rate of bile secretion and the excretion of bile acids and cholesterol by 21.8%, 18.6% and 19.0% respectively with no effect on the excretion of bilirubin.

Infusion of pyruvate increased the rate of bile secretion and the rate of excretion of bile acids and cholesterol content by 66.6%, 39.0% and 45.4% respectively, but reduces the bilirubin content by 75.0%. Succinate did not alter much the rate of bile secretion but increased the excretion of bile acids, bilirubin and cholesterol by 26.4%, 14.1% and 35.1% respectively. Citrate reduces the rate of bile secretion by 18.1% and the bile acids by 33.8%. Lactate increased

TABLE I

*Comparison of the effect palmitate, oleate, acetoacetate, pyruvate, succinate, citrate, lactate and the control sodium chloride and albumin on the rate and composition of bile constituents in bile*

	Control without any drug	Control with 0.9% NaCl	Control with albumin	Palmitate	Oleate	Acetoacetate	Pyruvate	Succinate	Citrate	Lactate
Rate of bile secretion mg./hour										
1 hour before perfusion	312	307	384	326	340	302	342	300	391	330
1 hour during perfusion	307	317	333	272	350	236	570	288	320	345
1 hour after perfusion	(-1.6)	(+3.3)	(-11.9)	(-16.5)	(+2.8)	(-21.8)	(+66)	(-4)	(-18)	(+4.5)
	337	337	290	250	318	303	618	238	312	348
	(+8)	(+10)	(-24)	(-23.3)	(-6.4)	(+2)	(+19)	(-2)	(-20)	(+5.4)
Bile acids mg./hour										
1 hour before perfusion	47.96	45.2	40.8	28.0	45.4	21.7	24.6	27.2	55.3	41.72
1 hour during perfusion	38.52	41.0	31.3	24.0	29.2	20.1	34.2	34.4	36.6	41.88
1 hour after perfusion	(-19)	(-9)	(-23.3)	(-14)	(-35.7)	(-18.6)	(+39)	(+26)	(-33.8)	(+0.4)
	33.04	42.5	19.5	21.0	20.6	33.3	25.6	26.0	26.6	30.19
	(-31)	(-4.5)	(-52.5)	(-25)	(-54.6)	(+35)	(-4)	(-4.4)	(-42)	(-27.6)
Cholesterol mg./hour										
1 hour before perfusion	2.36	2.22	2.1	1.4	1.6	2.1	1.1	1.7	2.2	3.08
1 hour during perfusion	2.2	2.4	1.4	1.0	2.7	1.7	1.6	2.3	2.4	3.90
1 hour after perfusion	(-6.8)	(+8.5)	(-33)	(-28.5)	(+68)	(-19)	(+45)	(+35)	(+8.5)	(+26.5)
	2.12	2.3	1.2	1.0	1.5	2.2	1.1	1.5	2.3	3.86
	(-10)	(+4.5)	(-42.8)	(-28.5)	(-6.2)	(+4.7)	(±0.0)	(-11.8)	(+4.5)	(+23.3)
Bilirubin mg./hour										
1 hour before perfusion	4.23	3.8	2.2	2.3	4.2	2.6	4.8	2.8	2.2	4.00
1 hour during perfusion	4.12	3.9	1.9	2.0	4.0	2.3	1.2	3.2	2.0	8.32
1 hour after perfusion	(-3.7)	(+2.6)	(-13.6)	(-13)	(-4.7)		(-75)	(+14)	(9)	(+108)
	4.22	3.7	1.5	1.8	3.7	3.8	1.0	2.8	2.0	8.02
	(-1.4)	(-2.6)	(31.8)	(-21)	(-11.9)	(+46)	(-80)		(-9)	(+100)

The figures in the parentheses are percentage increase (+) or decrease (-).

the rate by 4.5% cholesterol 26.5% and bilirubin by 108%.

#### DISCUSSION

The infusion of intermediary metabolites brings about significant alteration in the rate and composition of bile. It is interesting to note that the oleic acid which is an unsaturated fatty acid augments the excretion of bile, which is in agreement with the reports of Chabrol and Maximin<sup>3</sup> and Zuckerman *et al.*<sup>4</sup> The action of oleic acid is further characterised by concomitant increase in bile acids and cholesterol in bile. Palmitic acid which is a saturated fatty acid does not exhibit such an effect. It is also in agreement with the views of the various workers that hypocholesteræmic effect of unsaturated fatty acids is related to their influence on the excretion of bile acids through bile.<sup>6</sup> Acetoacetate on the other hand reduces the excretion of bile as well as the cholesterol and bile acids in it. One is tempted to suggest that the hypocholesteræmic effect of unsaturated fatty acids may be related to their influence on the bile and its constituents.

It is interesting to note that the intravenous administration of pyruvate evokes a powerful choleretic response, which is characterised by the concomitant increase in cholesterol and bile acids in bile. Lactate has been reported to exhibit a similar effect.<sup>1</sup> Succinate and citrate do not alter the rate of bile secretion but increase the concentration of the constituents of bile in it. These findings suggest that the sources of energy for the formation of bile are directly or indirectly linked to the intermediary metabolites of carbohydrate and unsaturated fatty acids.

Braur has demonstrated that the process of bile formation involves a process of active secretion supported by metabolic energy and is not based merely on a filtration reabsorption mechanism process.<sup>5</sup> Vanlernberghe<sup>7</sup> has also reported that the inhibitors of the enzymes involved in carbohydrate metabolism also inhibit the bile secretion. The increase in the constituents of bile after the administration of these intermediary metabolites can probably be due to their utilization for the biosynthesis of the constituents of bile.

It should be interesting to study whether the biliary response to sympathomimetic amines is in any way related to endogenous liberation of any of these metabolites in biophase. The work on this aspect is now in progress and

will be reported in subsequent communications from this laboratory.

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1. Kasture, A. V. and Dorle, A. K., *Curr. Sci.*, 1967, **36**, 669.
2. Heggeness, F. W., *Proc. Soc. Exp. Bio. Med.*, 1959, **101**, 143.
3. Chabrol, E. and Maximin, M., *La Presse Medicale.*, 1929, **41**, 666.
4. Zuckerman, I. C., Jacobi, M., Kogut, B. and Klein, B., *Am. J. Digestive Diseases Nutrition*, 1940, **7**, 208.
5. Braur, R. W., Lenog, G. F. and Holloway, R. J., *Am. J. Physiol.*, 1954, **177**, 103.
6. Gordon, H., Lewis, B., Eales, L. and Brock, J. F., *Nature*, 1957, **180**, 923.
7. Vanlernberghe, J., *Rev. Int. Hepatol.*, 1959, **9**, 497.

#### A SIMPLIFIED PROCEDURE FOR THE ESTIMATION OF STRONTIUM-90 IN SEA-WATER\*

The presence of large amounts of calcium and magnesium poses a major difficulty in the estimation of low levels of strontium-90 in environmental samples like sea-water, sediments and biomaterial. The conventional technique employed in the separation of strontium from calcium makes use of the insolubility of strontium salts in fuming nitric acid.<sup>1</sup> This procedure is tedious and time-consuming. Moreover, chemical yield is low and highly variable.<sup>2,3</sup>

Recently, ion-exchange and solvent extraction procedures have been developed<sup>4,5</sup> for the estimation of strontium-90 in various environmental samples. These procedures involve the initial precipitation of strontium along with calcium either as carbonate or oxalate followed by an ion-exchange separation of strontium from calcium or by the direct extraction of yttrium-90 from a mixture of strontium and calcium. These procedures again require the use of large ion-exchange columns or involve extractions of large volumes.

In the present paper, ferric hydroxide is used both for scavenging the fission products and naturally occurring radionuclides that interfere in the assay of yttrium-90 and also for collecting yttrium-90 after allowing it to come to equilibrium with its parent strontium-90. The separation of yttrium-90 from the carrier iron is achieved by ion-exchange.<sup>6</sup>



Surface sea-water samples were collected in polythene buckets and transferred to polythene carboys. Preliminary steps were carried out in 40 litres polythene containers.

Ferric nitrate (500 mg. of iron), barium chloride (250 mg. of barium) and ammonium chloride (40 gm.) were added to 40 litres of sea-water. The solution was stirred well for 5 minutes. Ammonia (40 ml. of 25% solution) was added to raise the pH of the solution to about 9.5. The solution was stirred again and the precipitate was allowed to settle overnight. The supernate was syphoned into another 40 litre polythene container and the above procedure was repeated. The two ferric hydroxide precipitates were discarded. The solution was acidified to a pH of 1-2 with concentrated hydrochloric acid, 20 mg. of yttrium carrier (as nitrate) was added and the solution was allowed to stay for at least two weeks for strontium-90 to come to equilibrium with its daughter yttrium-90.

To isolate yttrium 500 mg. of iron (as ferric nitrate) was added to the solution and ammonia was added to raise the pH of the solution to about 9.5. The precipitate formed was allowed to settle for 3-4 hours and the supernate was syphoned off. The precipitate was centrifuged, washed with distilled water and dissolved in 30 ml. of 10 N hydrochloric acid. The solution was passed through an anion exchange column (Dowex-1  $\times$  8, 50-100 mesh, chloride form, 2  $\times$  30 cm.) at a flow rate of 2 ml. per minute. The column was washed with 50 ml. of 10 N hydrochloric acid. The effluent was evaporated to near dryness and diluted to 50 ml. with distilled water. Yttrium was precipitated as hydroxide with ammonia. After centrifuging, the precipitate was dissolved in 2 ml. of 6 N hydrochloric acid. The solution was diluted to 15 ml. and yttrium was precipitated as oxalate by the addition of 20 ml. of saturated ammonium oxalate as described by Rodden.<sup>7</sup> The precipitate was filtered on to a 25 mm. Millipore filter, washed with alcohol and mounted in an aluminium planchet for counting. The precipitate was counted in a low background G. M. Counter. The decay of yttrium was followed for about 10 days. The entire radiochemical separation could be carried out in 6-8 hours.

Chemical yield was calculated by adding known amounts of strontium-90 in equilibrium with its daughter yttrium-90 to 40 litres of sea-water and estimating it by the procedure

described above. The results are given in Table I.

TABLE I

No.	Amount of strontium-90 added (cpm)*	Amount of strontium-90 recovered (cpm)	Yield %
1	591	363	61.4
2	591	390	66.0
3	591	402	68.0
4	591	374	63.3
		Mean	64.7
			$\pm 2.8\%$

\* Counting efficiency 10%, all samples were counted under the same geometry.  $\dagger$  One standard deviation of the mean.

A few sea-water samples collected from the Bombay Harbour Bay were analysed for strontium-90 and the results are given in Table II.

TABLE II

No.	Date of collection	Location	Strontium-90 (pCi/l)
1	17-1-1968	CIRUS Jetty*	$4.05 \pm 0.08$
2	24-1-1968	do.	$3.60 \pm 0.07$
3	7-2-1968	do.	$7.66 \pm 0.15$
4	9-2-1968	do.	$2.71 \pm 0.04$
5	7-3-1968	do.	$5.36 \pm 0.10$
6	13-3-1968	do.	$3.93 \pm 0.08$

\* Canada India Reactor Jetty.

Radioactive decay curves for yttrium-90 separated from two sea-water samples are given in Fig. 1.

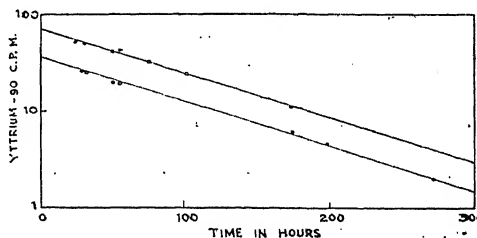


FIG. 1. Decay of yttrium-90 separated from two sea-water samples.

In order to determine the loss of strontium during ferric hydroxide precipitation known activities of strontium-85 were added to 40 litre samples of sea-water and the precipitation was carried out as described in the procedure. About 2% of strontium-85 activity was detected in the ferric hydroxide precipitate.

This method may be applicable to other environmental samples like sediments and bio-material after bringing them into solution with suitable acids.

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Bhabha Atomic C. SREEKUMARAN,  
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Bombay, July 11, 1968.

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1. Willard, H. H. and Goodspeed, E. W., *Ind. Engng. Chem. Analyst Edn.*, 1936, 8, 414.
2. Sugihara, T. T., James, H. I., Troianellow, E. J., and Bowen, V. T. *Anal. Chem.*, 1959, 31, 44.
3. Rocco, G. G. and Broecker, W. S., *J. Geophys. Res.*, 1963, 68, 4501.
4. Merritt, W. F., *Can. J. Chem.*, 1958, 36, 425.
5. Popov, N. I., Orlov, V. M., Patin, S. A. and Ushakova, N. P., *Okeanologia*, 1964, 4, Issue 3.
6. Kraus, R. A., Nelson, F., Clough, F. B. and Corlston, R. C., *J. Am. Chem. Soc.*, 1955, 77, 1391.
7. Rodden, C. J., *Analysis of Essential Nuclear Reactor Materials*, Division of Technical Information, United States of Atomic Energy Commission, 1964.

### PREPARATION OF NON-INFECTIOUS ARBOVIRUS ANTIGENS BY PHOTO-DYNAMIC INACTIVATION

THE inactivation of viruses by different dyes in the presence of light has been known for a long time.<sup>1</sup> Viruses thus inactivated retain their antigenicity and are able to produce immunity in animals.<sup>2-4</sup> Like other viruses, arboviruses were also found to be susceptible to photodynamic inactivation by neutral red.<sup>5</sup> In view of the possibility of the laboratory workers contracting virus infections from infected antigens it was thought worthwhile to explore the possibilities of preparing non-infectious antigens by photodynamic inactivation. The present communication reports the results of the experiments carried out in this respect.

The viruses employed in the study were Japanese encephalitis (JE) P20778 strain and the Kyasanur Forest disease virus (KFD) P9605 strain. Stocks were prepared from infected suckling mouse brains which were suspended in phosphate saline containing 0.75% bovalbumin, centrifuged at 12,100 g. for one hour and stored at  $-55^{\circ}\text{C}$ .

Stock dye solutions were made in distilled water at 0.1% concentrations and sterilized by autoclaving at 10 lbs. pressure for 10 minutes. The following dyes were employed: methylene blue (Grubler and Co., Leipzig), brilliant cresyl

blue (E. Merck A.G., Darmstadt), malachite green (B.D.H., England), Acriflavin (Western Pharma. Works, Bombay) and neutral red (National Aniline, U.S.A.).

Antigens were prepared from infected suckling mouse brains by the acetone-ether method of Clarke and Casals.<sup>6</sup> In some experiments saline extracted antigens treated with protamine sulphate were also employed.

Stock virus suspensions were diluted in phosphate buffered saline (pH 7.6) or in BAPS (pH 7.2) and transferred to a petri dish. The fluid depth was usually kept about 2 mm. Appropriate amounts of the dyes were added to the virus suspension so as to give 1:100,000 concentration of the dye in the reaction mixture. Light from a 100 watt microscope lamp filtered through a ground glass filter was allowed to fall upon the reaction mixture. In all experiments 400 foot candles of illumination was employed. Aliquot samples of 0.8 ml. were taken out at different intervals in test-tubes coated with black paint on the outside. Controls of unilluminated reaction mixtures (controls kept in darkness) with dye omitted (controls kept in light) were included in all the experiments. The reactions were carried out at  $4^{\circ}\text{C}$ . in a cold room.

The antigens were subjected to photoinactivation with cresyl blue under identical conditions.

Infectivity assays were made by intracerebral inoculations in mice. Haemagglutination tests (HA) were carried out by the method of Clarke and Casals,<sup>6</sup> and complement fixation (CF) tests by the method described by Pavri, *et al.*<sup>7</sup>

Preliminary screening for the capability of the different dyes of inactivating the viruses in the presence of light was done. Brilliant cresyl blue, methylene blue and neutral red were found to be effective. The remaining of the dyes were either inactive or very weakly active.

The kinetics of virus inactivation was studied with cresyl blue and neutral red. When the  $\log_{10}$  of the residual virus was plotted against the time of exposure to light, a straight line was obtained (Fig. 1) thus indicating a reaction of the first degree. The slope of the line obtained with cresyl blue was more steep than that with neutral red, thus indicating the faster rate of inactivation with cresyl blue. Though no kinetic studies were done with methylene blue, it appeared from the preliminary experiments that it inactivated

approximately the same amount of virus in about the same time as was with cresyl blue.

When the antigens prepared by acetone-ether extraction method were photoinactivated with cresyl blue, they were rendered non-infectious without any significant alteration in the HA and CF titres. The saline extracted protamine sulphate treated antigens behaved likewise.

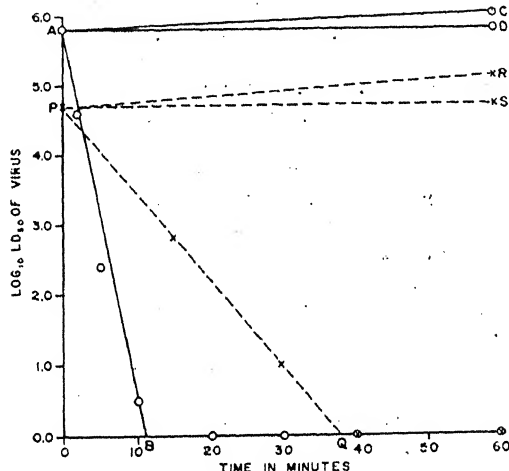


FIG. 1. Inactivation of J E virus with dyes.

- AB .. Inactivation with cresyl blue.  
AC .. Control with cresyl blue kept in darkness.  
AD .. Control without cresyl blue in light.  
PQ .. Inactivation with neutral red.  
PR .. Control with neutral red kept in darkness.  
PS .. Control without neutral red in light.

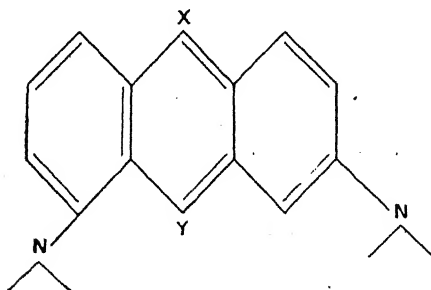


FIG. 2. General formula of photo-inactivating dyes.

From the above results it appears that cresyl blue is eminently suitable for photoinactivation of JE and KFD viruses. Methylene blue seems to be almost equally effective in producing photoinactivation. Crowther and Melnick<sup>8</sup> while considering the structures of the photo-dynamically active compounds, viz., neutral red, toluidine blue and acridine orange, showed close resemblance in chemical structure among

them. Figure 2 shows the general formula of the photoactive dyes. In the case of methylene blue the positions 'X' and 'Y' are occupied by nitrogen and sulphur respectively; in the case of cresyl blue by nitrogen and oxygen; and in the case of neutral red both the positions are occupied by nitrogen atoms. In acriflavin the position 'X' is occupied by a carbon atom and the position 'Y' by a pentavalent nitrogen. It was interesting to note that the strongly basic quinone-imine dye cresyl blue showed a faster rate of photoinactivation than the weakly basic neutral red also a quinone-imine dye. Acriflavin though a basic dye, belonging to the xanthene group was very weakly active. Malachite green which is a triphenyl methane dye was completely ineffective.

The photodynamically inactivated antigens do not show significant variations in titres from the untreated antigens in HA or in CF. Therefore this seems to be a simple and convenient method of preparing non-infectious antigens.

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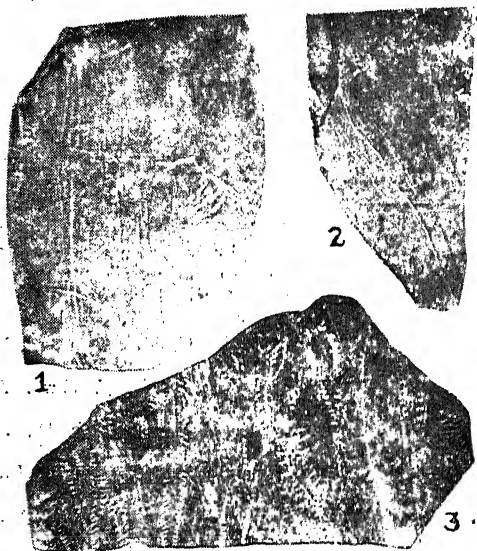
1. Perdrau, J. R. and Todd, C., *Proc. Roy. Soc.*, 1933, 112B, 288.
2. Dempsey, T. F. and Mayer, V., *J. Comp. Path. Ther.*, 1934, 47, 197.
3. Burnet, F. M., Keogh, E. V. and Lush, D., *Aust. Jour. Exp. Biol. Med. Sci.*, 1937, 15, 227.
4. Wallis, C., Sukpradn, N. and Melnick, J. L., *J. Immunol.*, 1963, 91, 677.
5. Tomita, Y. and Prince, A. F., *Proc. Soc. Exp. Biol. and Med.*, 1963, 112, 887.
6. Clarke, D. H. and Casals, J., *Amer. Jour. Trop. Med. and Hyg.*, 1958, 7, 561.
7. Pavri, K. M., Gokhale, T. B. and Shah, K. V., *Ind. Jour. Med. Res.*, 1962, 50, 153.
8. Crowther, D. and Melnick, J. L., *Virology*, 1961, 14, 11.

# ON THE OCCURRENCE OF SOME TRACE FOSSILS IN THE BHANDER LIMESTONE (UPPER VINDHYAN) OF REWA DISTRICT, M.P.\*

The present paper records the occurrence of trace fossils in the Bhandar Limestone Series of the Upper Vindhyan in the Bankuiyan (24° 01' : 81° 12'; 63 H/NW) area, Rewa District, Madhya Pradesh. The fossils dealt with in this paper consist of tracks and trails,

which are collectively designated as *trace fossils*,<sup>1</sup> and have been defined by Simpson as "sedimentary structures resulting from the activity of an animal moving on or in the sediment at the time of its accumulation; includes tracks, burrows, feeding marks, and other traces". The following are the brief descriptions of the trace fossils from the Bhandar Limestone Series:

*Bostricophyton bankuiyanensis* Verma and Prasad, n. sp. (G.S.I. Type No. 18355; Fig. 1): Large spiral thread-like markings, slightly broader in the middle and tapering at either ends; appears to be bound by an elongated head at one end; maximum length 70 mm. and width 1.5 mm.; transverse ridges thick, prominent, slightly arched and closely spaced. These markings appear to represent crawling tracks (Repichnia group of Seilacher) of a worm or an arthropod.



FIGS. 1-3. Trace fossils from Bhandar Limestone (Upper Vindhyan). Fig. 1. *Bostricophyton bankuiyanensis* Verma and Prasad,  $\times 1$ . Fig. 2. *Rouaulita rewanensis* Verma and Prasad,  $\times 1$ . Fig. 3. *Tasmanadia dassii* Verma and Prasad,  $\times 1$ .

*Rouaulita rewanensis* Verma and Prasad, n. sp. (G.S.I. Type No. 18356; Fig. 2): Smooth, long, bilobate crawling trail; maximum length 100 mm. and width 15 mm.; two very distinct lateral furrows and one median furrow; body almost flat. This marking appears to have been made by some worm and is attributable to Repichnia group of Seilacher. The present species has some resemblance to *R. rouaulti* (Lebesconte), reported from the

Lower Ordovician of France, but differs in having larger width, very distinct lateral furrows and almost flat lobes.

*Tasmanadia dassii* Verma and Prasad, n. sp. (G.S.I. Type No. 18357; Fig. 3): Double rows of very sharp transverse foot-like imprints; longer axis of the imprints slightly diagonal to the direction of movement; foot-like imprint single, thick, and varying in size according to its place in the body of the animal; imprints slightly tapering towards one end. These imprints seem to be foraging tracks, perhaps attributable to Pascichnia group of Seilacher, of an arthropod which has moved over the surface of the ocean floor in search of food. This species is named after the collector of this specimen, Shri S. Dass of the Geological Survey of India.

The presence of these trace fossils in the Vindhyan rocks affords an example of autochthonous life within or in the sediments and may be considered as additional evidence of sedimentation of Vindhyan in a shallow sea, a fact supported by the presence of ripple marks, etc. However, none of these trace fossils mentioned above affords any indication of the period to which the Upper Vindhyan should be referred to.

The authors are thankful to Shri C. Karunakaran, Deputy Director-General, for his keen interest and to Shri A. Hunday and Shri S. Dass for loan of material.

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May 3, 1968.

\* Published with the kind permission of the Director-General, Geological Survey of India, 27, Jawaharlal Nehru Road, Calcutta-13.

1. Hantzschel, W., *Treat. Invert. Palaeon.*, W, p. 177.

#### A NOTE ON TWO PALAEOOLITHS FROM GULER, DISTRICT KANGRA (HIMACHAL PRADESH)

IN February 1968, the present writer had an opportunity to visit Guler, District Kangra in the company of Dr. L. Vertes, Chief of the Department of Palaeolith of the Hungarian National Museum, Budapest. During the course of this short visit, Dr. Vertes and the writer were able to collect two examples of palaeoliths from the site. It may be stated here that while the examples discovered from time to time from Guler and the adjoining

areas belong to the distinct group of the 'Sohanian' (or 'Soanian') type of tools, particularly of the 'chopper-chopping' variety, no good examples of the bifacial type had so far been discovered from the region.

The two tools, one which (No. 1) is a good example of a bifacial 'chopping' tool, was embedded in the talus of Terrace 1, while the other one (No. 2) is a unifacial pebble tool, found at the junction of Terraces 2 and 3.

The two tools are described as under:

1. Bifacial 'chopping' tool on quartzite pebble. Crescentic cutting-edge which extends beyond half the periphery of the pebble; sub-angular butt. Large flakes removed from the major part of the dorsal surface, leaving the cortex near the bottom. On the ventral surface, small flakes removed towards the cutting-edge. The tool is unrolled and is in a good state of preservation. From the talus of Terrace 1. Measurements: major axis, 18 cm.; minor axis, 20 cm.; maximum thickness, 7.5 cm. (Fig. 1).

ventral face is flat and retains its original pebble, surface. The butt-end has become flat due to a later flake-scar. One later flake-scar is also present near the pointed end of the tool. From either Terrace 2 or 3. Measurements: length, 25 cm.; width, 18 cm.; thickness, 5.5 cm. (Fig. 2).

In the earlier explorations in the area, no clear examples of bifacial 'chopping' tools were found. The present example of the bifacial 'chopping' tool (No. 1), therefore, is significant for it clearly establishes not only the existence of bifacial chopping tools in the Guler assemblage but also in Terrace 1 itself.

In so far as the second specimen (No. 2) is concerned, it may be stated that it was found in a rain-gully and in all probability belongs to Terrace 3.

The earlier examples in this region found by Lal, and termed by him as handaxes, were rolled specimens of the bifacial variety and were found in Terraces 2 or 3.<sup>2</sup> The present example is, however, of the unifacial type although resembling a handaxe in shape.<sup>3</sup> It

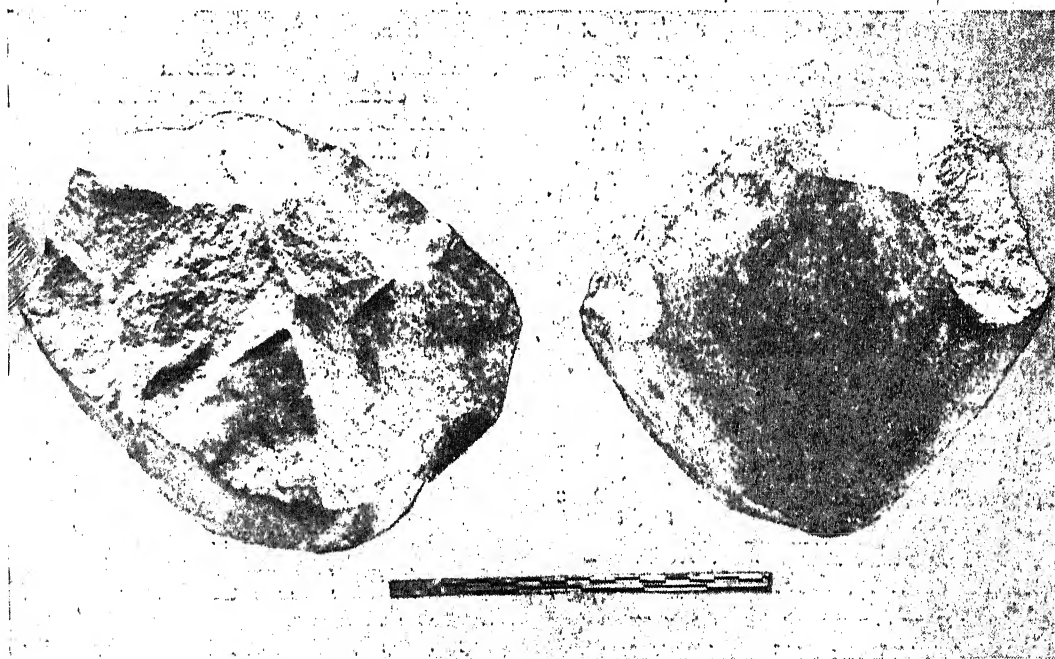


FIG. 1. Bifacial 'Chopping' tool from Guler.

2. Unifacial pebble handaxe, on a grey-coloured quartzite pebble. On dorsal face, long flakes have been removed to produce a pointed cutting end. The

may not, therefore, be wide off the mark if one postulates the existence of pebble handaxe facies alongside the chopper-chopping industry in the region.

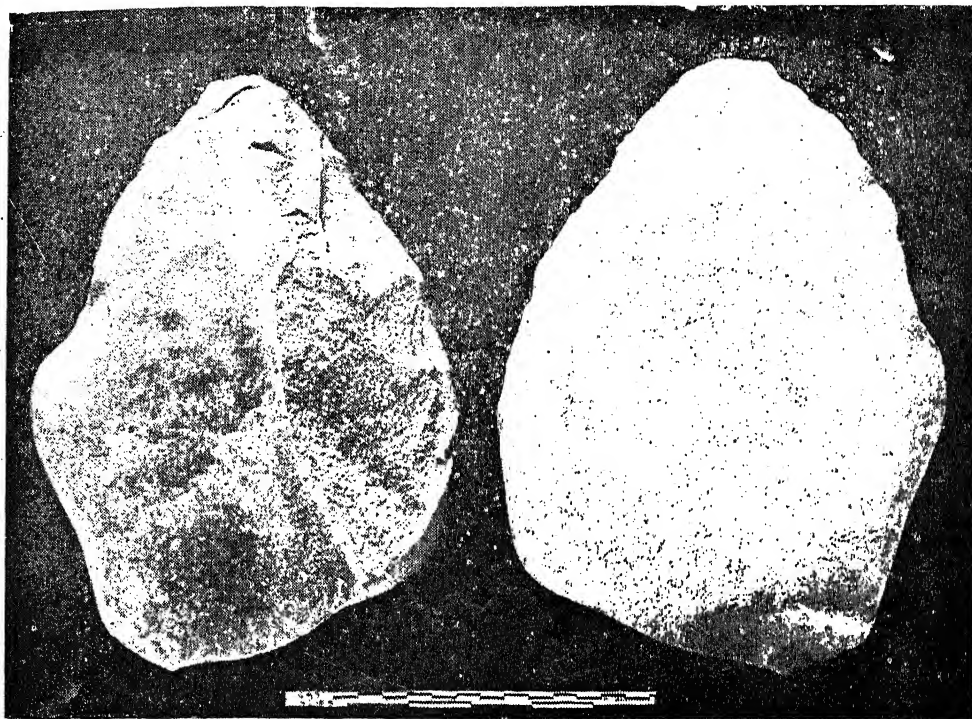


FIG. 2. Unifacial pebble handaxe from Guler.

Archæological Survey of India, B. M. PANDE.  
Janpath, New Delhi, June 19, 1968.

1. For a detailed description of the work done in Guler and the adjoining regions, see Lal, B. B., "Palaeoliths from the Beas and Banganga Valleys, Panjab," *Ancient India*, 1956, No. 12, pp. 58-92. The present note is, therefore, confined only a brief notice about the discovery of two more examples from Guler. The area was further explored by Dr. R. V. Joshi, of the Archæological Survey of India and Prof. W. Chmielewski, from Poland, during 1966-67.
2. *Ibid.*, pp. 66 & 70.
3. Sankalia prefers to call such types as proto-handaxes, Sankalia, H. D., *Stone Age Tools*, Poona, 1964, p. 47.

#### ALGAL STRUCTURES FROM ARAVALLI BEDS NEAR DAKAN KOTRA, UDAIPUR DISTRICT, RAJASTHAN\*

THE rocks occurring around Dakan Kotra ( $24^{\circ} 30' : 74^{\circ} 44'$ ) near Udaipur, are included under the Aravalli System of Archæan age and no evidence of life was described from the rocks of the group (Heron, 1953, p. 146). Recent geological mapping has resulted in the discovery of undoubted algal structures in the dolomites near Dakan Kotra and this note records some details of these structures and the significance of the find.

Dolomite, phyllite, carbon phyllite and quartzite occur in the area. The beds which strike north-south near Dakan Kotra gradually change to N.  $65^{\circ}$  E. to S.  $65^{\circ}$  W. further north. The dips are  $35^{\circ}$  to  $65^{\circ}$  towards west.

The dolomite showing stromatolites is exposed one kilometre west of Dakan Kotra and is found to extend for about 0.5 km. further to the west. It is fine-grained, grey in colour and has thin impersistent bands and patches of chert. The algal structures are well developed over a 100 m. long and 10 m. wide patch located 900 m. N.  $3^{\circ}$  W. of 2703 ( $24^{\circ} 29' 30'' : 73^{\circ} 43' 30''$ ). The different forms found resemble those described as 'weedia', 'collenia', 'cryptozoon' and 'codonophycus', (Cloud, 1942).

The 'weedia' type comprises parallel to sub-parallel straight running or wavy laminæ. The individual laminæ under hand-lens show minute crenulations.

The types which have been formed by the addition of convex laminæ include 'cryptozoon' with turbinate shapes, and 'collenia' having cylindroidal columns. Some of the 'cryptozoon' are up to 10 cm. in height and 13 cm. in width at the top. The 'collenia' are up to 8 cm. in height and 2 to 4 cm. in width. In plan they are irregular oval or circular.

The 'codonophycus' is also columnar in habit but the individual laminae are like cones. In the more common type, the apex of the lamina is curved while in the others it is pointed. The diameter of the cones varies from 5 to 7 cm. and the columns are nearly 30 cm. in height at places. The thickness of the laminae varies from a fraction of a millimetre up to 1 mm. and as many as seven laminae are present within a width of 1 cm. in the apical portions. The apical gap, i.e., the distance between the adjacent laminae near the apex of the cones, varies from 1 to 1.5 mm. The cone walls are thinner at the base and show thickening near the apex. In the varieties with the pointed apex, the ratio of height to diameter of the cones is 3 : 1 at the base and 8 : 1 in later stages.

The different types of stromatolites found in the area are intimately associated with one another and are probably derived by the agency of the same alga under different conditions of growth. The generic names used for describing stromatolites are thus used in this note as common nouns as done by Pettijohn (Pettijohn, 1957, p. 222).

Recent work has indicated that the pre-Cambrian rocks of Rajasthan can be grouped into pre-Aravalli and Aravalli Sequences only, the unconformity between the two being very distinct (Raja Rao, 1967). Absolute age data published for rocks of the Aravalli Group further indicate that they are of Proterozoic era (Sarkar et al., 1964). The algal structures found in the basal beds of the Aravalli rocks also indicate that life was already in existence in the early stages of the Aravalli geosyncline. Geological Survey of India, C. S. RAJA RAO.  
Rajasthan Circle, IQBALUDDIN.  
Jaipur, July 10, 1968. R. K. MATHUR.

\* Published by the kind permission of Director-General, Geological Survey of India.

1. Cloud, P. E., "Notes on Stromatolites," *Amer. Jour. Sci.*, 1942, **240**, 367.
2. Heron, A. M., "The Geology of Central Rajputana," *Mem. Geol. Surv. Ind.*, 1953, **79**, 27.
3. Pettijohn, F. J., *Sedimentary Rocks*, Harper and Bros., New York, 1957, p. 222.
4. Raja Rao, C. S., "On the age of the Precambrian Groups of Rajasthan," *Jour. Mines, Metals and Fuels*, 1967, **4** (4), 306.
5. Sarkar, S. N., Polkanov, A. A., Gerling, E. K. and Chukrev, F. V., "Geochronology of the Precambrians of Peninsular India—A Synopsis," *Sci. & Cult.*, 1964, **30** (11), 527.

# **CAYEUXIA FRUCTILOSA JOHNSON** **FROM THE BAGH BEDS,** **MADHYA PRADESH**

The present communication reports the occurrence of *Cayeuxia fructilosa* Johnson in the Coralline Limestones of the Bagh Beds of the Man river section, M.P. The Bagh Beds of West-Central India represent the marine deposits of Cretaceous transgressive cycle which inundated much of Western India. The presence of algæ (Coral-linaceæ) in the Cretaceous of Narbada Valley was briefly commented upon by Chiplonker (1944). Recently, the authors took up a detailed study of the algæ in these beds and found, among others, *Cayeuxia fructilosa*, a codiacean alga, which is being reported for the first time from the Indian sub-continent. This occurrence is significant since the species was originally described by Johnson (1965) from the upper horizon of the San Cristóbal Formation which consists mainly of fossiliferous gray to tan limestones of Campanian-Maestrichtian age and a Maestrichtian age has been assigned for the species.

## SYSTEMATIC DESCRIPTION

Phylum **CHLOROPHYCOPHYTA** Papenfuss, 1946  
Class **CHLOROPHYCEAE** Kuetzing, 1843  
Order **SIPHONALES** Wille, 1884  
Family **CODIACEAE** (Trevisan) Zanardini, 1943  
Genus *Cayeuxia* Frollo, 1938  
*Cayeuxia fructilosa* Johnson, 1965

(Figs. 1, 2)

*C. fructilosa* Johnson, 1965, pp. 71-72, pl. 12, figs. 1-2; pl. 13, figs. 1-3.

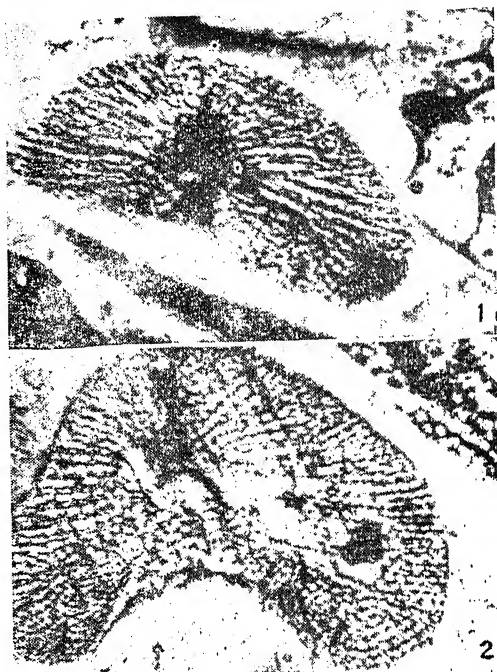
**Description.**—Thallus irregular, more or less rounded; upto 2-2.5 mm. across. Tubes 10-18  $\mu$  in diameter. Branching at wide angles. Branching frequent, particularly near periphery. Diameter varies in the same tube.

**Remarks.**—The material is essentially the same as described by Johnson (1965) from Guatemala and British Honduras. A Late Upper Cretaceous to Maestrichtian age has been assigned to the species. This is in full conformity with the age as suggested by Pal (1967) for the Upper Coralline Limestones from which the species is being reported.

**Horizon and Locality.**—Upper Coralline Limestone; Deola, Sitapuri; Maestrichtian.



Figured slides. CL. 01, CL. 19.



FIGS. 1-2,  $\times 75$ .

Thanks are due to Dr. J. Harlan Johnson, Emeritus Professor of Geology, Colorado School of Mines, who took much interest in the present work and made valuable suggestions.

Palaeobotany Laboratory, A. K. GHOSE.  
Department of Botany, A. K. PAL.  
Calcutta University, June 1, 1968.

1. Chiplonker, G. W., *Sci. & Cult.*, 1944, **10**, 3.
2. Frollo, M. M., *Soc. Géol. France Bull.*, 1938, **6**, Ser. 5, Tome 8, Fasc. 3-4.
3. Johnson, J. H., *Prof. Contribution of Colorado School of Mines*, 1965, No. 1.
4. Pal, A. K., *M.Sc. Thesis* (Unpublished), Submitted to Jadavpur University, 1967.

### THE NATURE OF FLUID IN THE EGG OF *CALOTES VERSICOLOR*

THE egg of *Calotes versicolor* is creamy-white with a soft leathery shell. On pricking a viscous fluid oozes out from about the third day of incubation. Nothing much is known about the nature of this fluid. One comes across references about the presence of albumen or egg white in the eggs of crocodiles and tortoises. Clark<sup>1</sup> believes in the presence of albumen in the eggs of black snake; however, according to Young<sup>2</sup> and Bellairs<sup>3</sup> there is

little, if any, albumen in the eggs of lizards and snakes. It is in this context that the eggs of *Calotes versicolor* are studied in the present investigation.

The outer shell layers of the entire eggs of calotes, at various stages of development were peeled off for proper infiltration, fixed in Smith's fixative,<sup>4</sup> dehydrated, cleaned in benzene and cut serially at 12  $\mu$ . Sections were stained with Erlich's haematoxylin and mounted in balsam. On studying the sections it was observed that allantois makes its appearance early in the development and completely surrounds the yolk sac by about the 15th day of development, just as was observed by Weekes<sup>5</sup> for the two species of snakes, *Denisonia suta* and *Denisonia superba*.

In calotes, the histological structure throughout the length of the oviduct is the same and does not show the presence of albumen glands. It seems that real albumen is probably absent in calotes egg. Thus the viscous fluid which could be collected from the early period is allantoic fluid. In order to confirm that this fluid is not albumen, it was analysed for its contents, by the various tests described by Cole.<sup>6</sup> It was found that the egg fluid of calotes does not contain all the constituents of albumen but only some mucoproteins.

Total proteins present in the fluid at various stages of development of calotes were estimated colorimetrically by the method described by Lowry and others.<sup>7</sup> From Table 1 it could be seen that protein content of the fluid increases during calotes development.

TABLE 1  
Protein in fluid of calotes egg

Age in days	Total amount of fluid per egg (ml.)	Protein in total fluid per egg (mg.)
3	0.05	0.015
12	0.27	0.634
24	0.3	0.975
34	0.5	1.335
43	0.5	2.260

This fluid with nutritional role like albumen would not show such an increase in its protein content. Moreover this fluid is found to contain the waste products of nitrogen metabolism.<sup>4</sup> It thus seems justifiable to conclude that real albumen is probably absent in calotes egg and the fluid in the egg is not albumen but allantoic fluid. Nevertheless the presence of proteins in this allantoic fluid might have some significance of its own.



Department of Zoology, LEEIA MULHERKAR,  
University of Poona, M. V. AHTAVALE.  
Poona-7, December 30, 1967.

1. Clark, H., *J. Expt. Biol.*, 1953, **30**, 492.
2. Young, J. Z., *The Life of Vertebrates*, 2nd Edition, Oxford University Press, 1962, p. 381.
3. Bellairs A. D'A., *Reptiles*. London Hutchinson's University Library, 1957, p. 45.
4. Gray, P., *The Microtome's Formulary and Guide* by Peter Gray, Constable and Company Ltd., London.
5. Weekes, C., *Proc. Zool. Soc.*, Part II, 1935, p. 625.
6. Cole, S. W., *Cole's Practical Physiological Chemistry*, 10th Edition, W. Heffer & Sons Ltd., Cambridge, 1955.
7. Lowry, O. N., Rosenbrough, A. and Randall, R., *J. Biol. Chem.*, 1951, **193**, 265.
8. Athavale, M. V. and Leela Mulherkar, *J. Anim. Morphol. Physiol.*, 1967, **14**, 89.

# ADULTS OF EUMEGACETES ARTAMII FROM WHITE LEGHORN PULLETS INFECTED WITH THE METACERCARIAE FROM TWO DRAGONFLIES

*Eumegacetes* (Lecithodendriidae, Trematoda) occurs in the rectum and the cloaca of a great variety of wild birds in Africa, Brazil, Europe, Formosa, Havana, India and Russia. To the twelve species listed under this genus by Yamaguti,<sup>3</sup> eight others have been added. Of these, the eleven Indian species are: *E. artamii* and *E. braunii* Mehra, 1935; *E. microdiosus* Chaudhan, 1940; *E. mehraii* Jha, 1943; *E. riparius* Gupta, 1957; *E. singhi* Jaiswal, our studies on the distribution of metacercarial *E. megacetaulus* and *E. hyderabadensis* Jaiswal and Vasudev, 1960. Most of the species so far named are based on the study of a single specimen. The differential characters stressed by the authors in justification of their species are not infrequently of minor significance and often appear overlapping which naturally tends to make the taxonomic concept somewhat confused.

Hanumantha Rao and Madhavi<sup>2</sup> reported the metacercarial cyst of *Eumegacetes* in the naiads of the libellulid dragonflies. During our studies on the distribution of metacercarial cysts in the local dragonflies, a typical eumegacetid metacercaria has earlier been recorded from a male of *Brachythemis contaminata* (Fabr.).<sup>1</sup> Cysts of this type, also encountered in *Orthetrum sabina* (Drury), were fed to three clean pullets reared in the laboratory. 18 metacercariae were administered to one

pullet; 19 cysts to another but on four different dates; and 9 cysts to a third pullet. The droppings of the first, amongst the infected pullets, alone became positive for the characteristic eggs on the 16th day after infection. The autopsy, conducted on the 19th day after infection, yielded two mature flukes—one from the *Bursa fabricius* and the other from the *Cloaca*. These specimens were fixed in 10% formalin and subsequently stained and mounted—one being a pressed form. This has been studied for its morphology and measurements. The other helminths collected were tapeworms—10 specimens of *Railletina cesticillus* and 12 specimens of *R. tetragona*.

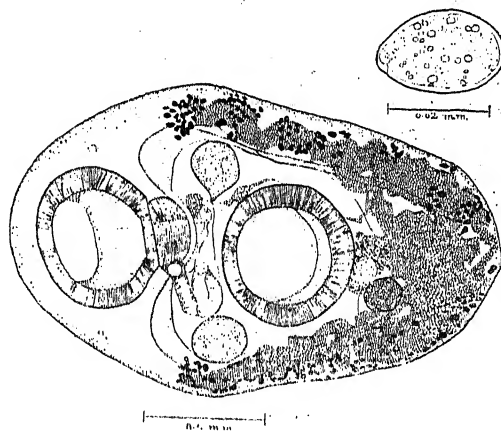


FIG. 1

The nearly elliptical body, with aspinose cuticle and rounded ends, measured 2.17 mm. in length and 1.23 mm. in maximum breadth lying in the preacetabular zone. It had the subterminal oral sucker of  $0.50 \times 0.58$  mm.; the pharynx of  $0.27 \times 0.15$  mm.; the acetabulum, of  $0.58 \times 0.59$  mm. lying immediately behind the middle of the body; chambered excretory cornua; the slightly dextral genital opening at the level of the mid-pharyngeal region; symmetrical and intercæcal but immediately preacetabular testes; with the right one of  $0.27 \times 0.22$  mm. and the left of  $0.24 \times 0.22$  mm.; the cirrus sac lying to right of the median line, between the anterior margin of the acetabulum and the right intestinal cæcum, somewhat crescent-shaped; with a coiled seminal vesicle in its swollen basal half and a prominent pars prostatic area; spherical ovary immediately postacetabular, dextral,  $0.17 \times 0.14$  mm. with the pear-shaped

receptaculum seminis lying medianly between it and the acetabulum; uterine coils post-ovarian and lateral, mostly extracæcal, with the ascending limb along the left margin of the acetabulum on way towards the genital pore; vitelline follicles lateral, along intestinal cæca, extending from the level of the genital pore to the posterior end; ova yellowish-brown, oval with a narrow opercular end,  $20.2-26.4 \mu \times 14.1-16.5 \mu$  in size.

The specimen, though smaller in dimensions, tallies in general with the morphology described for *E. artamii* and *E. riparius*. Gupta<sup>1</sup> distinguished *E. artamii* from his species on the aspinose chamber of the body wall, non-chambered feature of the excretory cornua and the cirrus sac being much swollen basally but crescent-shaped anteriorly. On account of its smooth cuticle and the swollen character of the basal region of the cirrus sac, our material agrees with the account given by Mehra who has, however, not indicated the chambers of the main excretory vessels which, as mentioned by Gupta, is shared by the present material. Evidently, this character cannot be relied upon. *E. riparius* seems to be the only species in which minute backwardly pointed spines have been described. The metacercariæ used in this feeding experiment and the adults recovered did not exhibit any spination. Accordingly, the two specimens are assigned to *E. artamii* for which domestic fowl has been found to act as a susceptible definitive host. The present finding, as far as could be ascertained, is a first report of the successful development of a eumegacetid fluke from its metacercarial stage in birds.

Department of Parasitology, PRATAP SINGH.  
U.P. College of Veterinary B. P. PANDE.  
Science and Animal  
Husbandry, Mathura,  
December 26, 1967.

1. Gupta, R., *Proc. Nat. Acad. Sci. India*, 1957, 27, 261.
2. Hanumantha Rao, K. and Madhavi, R., *Curr. Sci.*, 1961, 30, 303.
3. Mehra, H. R., *Proc. Nat. Acad. Sci. India*, 1935, 5, 99.
4. Prakash, R. and Pande, B. P., *Indian J. Helm.*, 1968 (In press).
5. Yamaguti, S., *Systema Helminthum*, Vol. I: *The Digenetic Trematodes of Vertebrates—Part I*, Interscience Publishers, Inc., New Ysrk, 1958, p. 979.

## ON THE STERILE CULTURE OF EXCISED SHOOT TIPS OF *MARSILEA MINUTA* L.

ALLSOPP<sup>1</sup> initiated the aseptic culture of *Marsilea* species studying mainly the heteroblastic leaf development and the production of land or water forms in the morphogenesis of *Marsilea* sporelings.<sup>3-5</sup> He employed only Knop's solution supplemented by Berthelot's solution (after Gautheret) throughout his experiments. Our endeavour here was to try to culture shoot tips of some suitable species of *Marsilea* on a different medium more conducive to growth under ordinary room conditions during winter season in India and other tropical countries. We have successfully introduced White's<sup>7</sup> basal medium to culture excised shoot tips of *Marsilea minuta* L. within the framework of our limited culture resources.

Schneider<sup>6</sup> and others have established that in *Marsilea* the shoot apex segmentation is very regular; one root and one lateral bud meristem being produced with each leaf and even the terminal millimeter of the rhizome, thus carries them. Following Allsopp,<sup>4</sup> the treminal millimeter of the stem tips from normal healthy plants were excised aseptically. They carried only one externally visible leaf primordium and no visible roots. The apices were sterilized superficially by treatment with chlorine water followed by changes of sterile water before their inoculation to culture vessels. Other exposed surfaces were sterilized using ultra-violet lamps and absolute alcohol. In the preparation and composition of the medium White's<sup>7</sup> method was literally followed. The medium contained 2% sucrose (A.R.) and 5 g. of 'Difco' agar was added to each litre of nutrient for preparing semi-solid medium, adjusted to pH 6.00. The cultures were grown in cotton plugged 'Pyrex' glass tubes of  $15 \times 2.5$  cm. and 250 ml. 'Corning' flasks charged with 20 ml. and 50 ml. of the nutrient respectively. We maintained them at room temperature, illuminated round the clock by daylight fluorescent lamps (40 watt, 4') suspended 2 feet above the cultures. Observations were recorded during November 1967 to April 1968.

After inoculation rapid growth commenced soon with the appearance of usually 2 to 4 small, linear, subulate leaves each lacking a distinct lamina. In some of them the petiole terminated distally with a reduced flattened laminar surface (Fig. 1, a). The lateral bud,



FIG. 1. Four-months old plants in culture with all the leaf types and lateral branches. (a, Juvenile leaves; b, Bifid leaves; c, Quadrifid leaves; d, Roots; e, Lateral branch.)

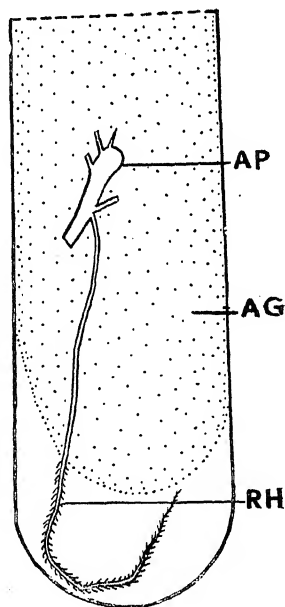


FIG. 2. Diagrammatic sketch of a root enlarged to show root hairs. (AG, Agar medium; AP, Apex of the stem; RH, Root hairs.)

already present in the axil of the pre-existing visible leaf, simultaneously grew more vigorously producing a lateral branch with lesser number of juvenile leaf types and attained early a normal quadrifid leaf pattern. The usual quadrifid leaves (Fig. 1, c) were preceded by one to several bifid leaves (Fig. 1, b). The progressive elaboration of the laminar surface in the cultured plants runs parallel to the extensive root development in them. Roots produced in the agar medium were stout and more or less straight rarely forming spirals in contrast to the observations of Allsopp.<sup>2</sup> Curiously enough, in some of the culture tubes an enormous development of conspicuous, hyaline root hairs was manifest in those regions of the roots which became exposed to the air of the culture tube after coming out of the medium (Fig. 2). These root hairs helped the roots in clinging to the inner walls of the tubes. No such extensive development of root hairs was discernible in normal aquatic plants.

Similar isolated shoot apices when cultured in tubes and flasks containing identical nutrient medium did not grow identically. The plants of the flasks produced lesser number of juvenile leaf types with no bifid leaves. The more extensive development of the laminar surface in the plants cultured in flasks seems to be conditioned to some extent by better availability of space in them. Nutrient medium supplemented with IAA in the final concentrations of  $10^{-7}$  yielded better growth of excised stem tips. Our cultures in liquid medium presented greater susceptibility to fungal and bacterial contamination under room conditions. On the whole, our observations agree in essential details with those of Allsopp.<sup>1-6</sup> Further studies on the morphogenesis of *M. minuta* L. with special reference to its sporocarp development in sterile cultures are in progress.

The authors are indebted to Professor K. S. Bhargava for laboratory facilities and one of us (S. M. Tripathi) acknowledges the financial assistance by the CSIR, New Delhi.

Department of Botany, S. M. TRIPATHI.  
University of Gorakhpur, D. N. SHARMA.  
Gorakhpur (U.P.), June 19, 1968.

1. Allsopp, A., *Nature*, 1951, **168**, 301.
2. —, *Ibid.*, 1952a, **169**, 1019.
3. —, *Ann. Bot.*, N.S., 1952b, **16**, 165.
4. —, *Ibid.*, 1953a, **17**, 37.
5. —, *Ibid.*, 1953b, **17**, 447.
6. Schneider, F., *Flora*, 1913, **105**, 347.
7. White, P. R., *The Cultivation of Animal and Plant Cells*, New York, 1954.

# A NEW SPECIES OF PHAEOPHLEOSPORA AFFECTING ACHRAS SAPOTA L.

*Achras sapota* L. as chiku or sapota is an important fruit crop grown widely in coastal regions all over India. During a survey for new diseases several sapota trees growing at the horticultural garden in the campus of the Agricultural College, Dharwar, were found to be severely affected by a leaf-spot disease, which has not so far been reported from other sapota-growing regions of India. Initial infection is in the form of minute, pinkish circular spots scattered over the lamina with a whitish centre and black hemispherical pustular structures representing the fruit bodies of the pathogenic fungus (Fig. 1). Isolations from the infected leaf-spots yielded a species of *Phaeophleospora*. It was found to be extremely slow-growing and a shy sporulator.

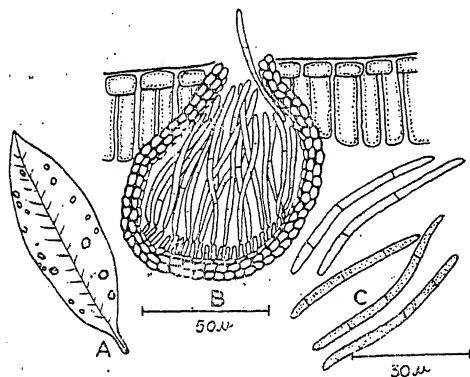


FIG. 1. A—Habit; B—Section through an infected leaf showing pycnidium; C—Pycnidiospores.

**Identity and Diagnosis.**—Comparative study between the writer's collection and the type species gave the results as in Table I.

The *Phaeophleospora* species on *Achras sapota* is thus significantly distinct from the type, besides being pathogenic to a hitherto unreported host and therefore needs accommodation in a new taxon with the following Latin diagnosis.

*Phaeophleospora indica* Chinnappa sp. nov.

Infectionis maculae, circulares, amphigenis, sparsis magnit 0.4–1.3 mm. diam. Pycnidii stromatic, separatus ad aggregatus, innatus, dark brunneus, globosus, ostiolatis epiphyllis, magnit 48–111 × 36–100 μ, conidiophoris simple, brevis, hyalinis in basali stratum. Pycnidiosporiis filiformibus, brunneus, rotundatus ad ambo extrema, 2–4 septatis non-constrictus ad septa, magnit 33.5–55.5 × 2.5–3.5 μ.

In foliis viventibus, *Achras sapota* L. Leg. V. S. Seshadri ad Dharwar (Mysore State, India, 5-12-1967), M.A.C.S. Mycol. Herb. Sub-numero 483 (Typus).

The form-genus *Phaeophleospora* is a new addition to Indian fungi.

Grateful thanks are due to Prof. M. N. Kamat for his guidance and to Dr. V. G. Rao and Dr. V. S. Seshardi for general help.

M.A.C.S. Biological Labs., B. CHINNAPPA.  
Poona-4, February 10, 1968.

1. Saccardo, P. A., *Syll. Fung.*, 1931, 25, 618.
2. Bond, T. E. T., *J. Sci.*, Sect. A, 1947, 12, 185.

TABLE I  
Comparative studies between species of *Phaeophleospora*

Species	Pycnidia	Pycnidiospores	Authority
<i>Phaeophleospora euginiae</i> ..	100–160 μ diam.	Constricted at septa. 60–90 × 3–5 μ	Rangel, E., 1916 (cf. <i>Syll. Fung.</i> )
<i>Phaeophleospora</i> sp. (on <i>Achras sapota</i> )	48–111 × 36–100 μ	Non-constricted at septa. 33.5–55.5 × 2.5–3.5 μ	Author

**Causal Organism.**—In sections the spots revealed the presence of a pycnidial fungus which was identified as a species of the form-genus *Phaeophleospora* Rangel (Fig. 1, B). This genus was established by Rangel with *Phaeophleospora euginiae* as type parasitizing *Euginea uniflora* L., and is represented by only two known species, the other being *Phaeophleospora elaeocarpi* Bond. There is no report of a *Phaeophleospora* on any member of the family "Sapotaceae" or on *Achras sapota*.

## EFFECTS OF GROWTH RETARDANTS ON FLOWERING AND FRUITING OF LANGRA MANGO

CONTROL of flowering in fruit plants by application of chemicals is gradually gaining interest in the field of horticultural research. Recently developed growth retarding chemicals provide the means for suppressing growth and inducing flowering of a wide variety of plants. Of the most commonly used growth retardants

like N-dimethyl amino succinamic acid (B-Nine), (2-chloroethyl) trimethyl ammonium chloride (cycocel) and 2,4-dichlorobenzyl tributyl phosphonium chloride (Phosfon), B-Nine and cycocel are reported to be most promising in respect of their growth retarding and flower promoting effects on apples, pears and cherries.<sup>1-7</sup>

In the present investigation the effect of B-Nine and cycocel on flowering and fruiting of a biennial mango variety, *Langra*, has been studied with the object of controlling its irregularity of fruiting.

The experiment was conducted during 1967-68. Four replicated *Langra* trees, in their 'off' year, were employed. The growth retardants applied, in aqueous solution, in two concentrations each were (i) B-Nine—500 and 1000 ppm. and (ii) cycocel—1000 and 2000 ppm. Also a control with application of water alone was provided. Five limbs of uniform size per tree selected at random were used for the five treatments, given three times at fortnightly intervals, starting from the middle of May, when the trees were in active vegetative growth. Tween-20 (0.1% soln.) was used as wetting agent. The effectiveness of the growth retardants was measured by the percentage of treated shoots flowering the following spring and the number of fruits recorded per treated limb at harvest.

Tables I and II show the results obtained with respect to mean percentage of shoots

TABLE I

Effect of growth retardants on flowering of *Langra* mango as expressed by the percentage of shoots flowering

Concentration	Control	Low	High
Growth retardants:			
B-Nine	23.60	41.67	55.36
Cycocel	23.60	51.18	71.25

TABLE II

Effect of growth retardants on fruiting of *Langra* mango as measured by number of fruits per treated limb at harvest

Concentration	Control	Low	High
Growth retardants:			
B-Nine	6.75	7.25	6.50
Cycocel	6.75	5.50	16.50

N.B.—Low concentration=500 ppm. B-Nine and 1000 ppm. cycocel, High concentration=1000 ppm. B-Nine and 2000 ppm. cycocel.

flowering and the mean number of fruits per limb at harvest respectively.

The results indicate beneficial effect of both B-Nine and cycocel on flower induction in *Langra* mango. Between the two chemicals, cycocel is found to be more effective and between the two concentrations used the higher ones have given a greater effect. On harvest of fruit, however, only cycocel in the higher concentration has shown a marked advantage.

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University College of  
Agriculture,  
Calcutta University,  
June 19, 1968.

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P. K. SEN.

1. Anonymous, *Ann. Rep. East Malling Res. Sta.*, 1964, 1965, p. 11.
2. Batjer, L. P., Williams, M. W. and Martin, G. C., *Proc. Amer. Soc. Hort. Sci.*, 1964, 85, 11.
3. Cathey, H. M., *Farm Chem.*, 1964 C. 127 (1), 29.
4. Edgerton, L. J. and Hoffman, M. B., *Proc. Amer. Soc. Hort. Sci.*, 1965 a. 86, 28.
5. — and Blanpied, G. D., *Proc. N.Y. State Hort. Sci.*, 1965 b, 1965, p. 161.
6. Fisher, D. V. and Looney, N. E., *Proc. Amer. Soc. Hort. Sci.*, 1967, 90, 9.
7. Monselise, S. P. and Halney, A. H., *Ibid.*, 1964, 84, 141.

## A SYMPTOMLESS CARRIER OF SANDAL SPIKE DISEASE

REPORTS exist in literature that the undergrowth of sandal forest may have an influence in inducing the spike disease. Among the herbaceous weeds, *Lantana camara* has been particularly mentioned by early workers as having a marked influence on insect population.<sup>1</sup> Venkata Rao<sup>2</sup> and Ranganathan<sup>3</sup> observe that vast stretches of *Lantana* seem to pre-dispose sandal parasitic on roots of *Lantana* and this herb may be the ultimate cause of degradation of sandal forests in North Salem. Sreenivasaya<sup>4</sup> stated that elimination of *Lantana* effects remarkable ecological changes in sandal forests. All authors agree on *Lantana* being partially responsible for the onset of spike disease in sandal. The present study is undertaken to find experimentally if *Lantana* is a symptomless carrier of sandal spike virus.

**Materials and Methods.**—Plants of *Lantana camara* were collected from areas where there were no sandal trees and were potted in garden loam. At the 4 leaf stage, these plants were inoculated with extracts of healthy and diseased sandal leaves following the methods

reported by Menon-Nayar.<sup>5</sup> The pots were kept in ordinary wire mesh cages covered with muslin cloth, in diffused daylight at temperatures varying from 15–27° C. Lots of 25 *Lantana* plants each, were respectively treated with diseased and healthy sandal leaf extracts; controls were treated with distilled water. The period of incubation varied from 30–50 days. The leaves from *Lantana* were harvested after 30, 40 and 50 days; the saps prepared in buffer from these were inoculated on the indicator test plants, *Stachytarpheta indica* Valhi. The results are given in Table I.

TABLE I

Infection index of *S. indica* treated with sap  
*Lantana camara* previously inoculated with  
sap from spiked sandal

Source of inoculum	Incubation period of <i>Stachytar-</i> <i>pheta</i> in days	No. of plants treated/ No. infected
<i>Lantana</i> sap from leaves previously inoculated with diseased sandal	30	25/15
leaf extract	40	25/18
	50	25/12
<i>Lantana</i> sap from leaves previously inoculated with healthy sandal	30	25/0
leaf extract	40	25/0
	50	25/0
Control previously treated with distilled water	30	25/0
	40	25/0
	50	25/0

The extract from spiked sandal does not produce any visible symptom when inoculated on *Lantana* but when extract from such inoculated *Lantana* was rubbed on healthy indicator plant, *Stachytarpheta indica*, symptoms of rolling of leaves and progressive stunting of newly formed leaves (Fig. 1, A) were produced in a similar way to those manifested

by rubbing of spiked sandal extracts on *S. indica*. The control test plants *Lantana* inoculated with healthy sandal leaf extract did not show any abnormal symptom (Fig. 1, B). From these experiments *Lantana* appears to be a symptomless carrier of spike disease. This may explain the correlation between the virulence of spike in sandal forests and *Lantana* population.

Forest Research Laboratory, R. NAYAR.  
Bangalore, June 3, 1968. R. A. SRIMATHI.

1. Dover, Cedric, *Ind. For. Records (Ento.)*, 1933, 17, Part I.
2. Venkata Rao, M. G., "The role of undergrowth in the spread of spike disease of sandal," *Ind. For.*, 1935, p. 169.
3. Ranganathan, C. R., *Working Plan for Nilgiris Division*, 1941, p. 21.
4. Sreenivasaya, M., "The spike disease of sandal," *Curr. Sci.*, 1948, 17, 141.
5. Menon-Nayar, "Sap transmission of sandal spike," *J. Expt. Biology*, 1967, 5 (3), 195.

#### AN INHIBITOR OF LEAF AND GLUME PIGMENT IN WHEAT

Two bread wheat varieties, Cadet (a Canadian variety) and Sonora 64 (a Mexican dwarf) have no pigment (purple) in leaf-auricles and glumes. The  $F_1$  plants from the cross of these varieties also do not show any pigment in leaf-auricles and glumes. But the monosomic ( $2n-1=41$ )  $F_1$  plants from a cross between Cadet monosomic XXI  $\times$  Sonora 64 showed a very conspicuous purple pigment in the auricles of leaves. The pigment shows as purple patches or flakes in the auricle and junction of the leaf-blade and leaf-sheath when the seedlings are half-natured. In the green spikes the pigment develops as a purple line along the rim of the glume giving the glume, and so, the spikes a brownish colour when ripe, the rim of the glumes becoming darker brown. Glumes and spikes of non-pigmented plants are distinctly whitish in colour when ripe.

It is apparent from this observation that there are gene (or genes) for leaf and glume pigments in the variety of Cadet and that there are inhibitor gene (or genes) located on chromosome 7 D (XXI) of the same variety, in absence of which the pigments in leaves and glumes are expressed.

Division of Genetics, JADU G. BHOWAL.  
Indian Agricultural M. P. JHA.  
Research Institute,  
New Delhi-12, July 10, 1968.

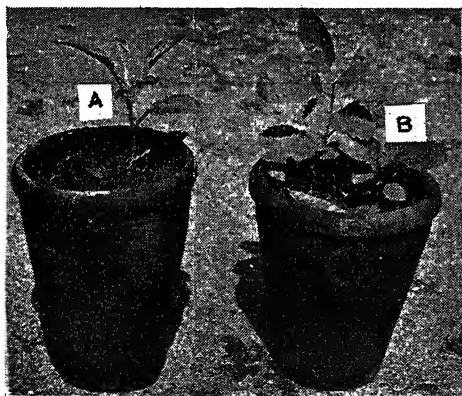


FIG. 1 A-B

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## REVIEWS AND NOTICES OF BOOKS

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### Marine Chemistry (Vol. I)—*Analytical Methods*.

By Dean F. Martin. (Marcel Dekker, Inc., New York), 1968. Pp. viii + 280. Price \$ 5.75.

The field of marine chemistry may be divided into two subject areas: Theory and Analytical Methods. Marine Chemistry is an experimental science with considerable efforts devoted to the collection of water samples and analysis of constituents.

Volume I under review *Analytical Methods* contains an examination and discussion of the current laboratory procedures for analyzing common constituents of natural waters, with theory and practice presented as an integrated whole. The commonly used determinations of marine chemistry are critically reviewed; specific directions are given for each determination. Many of the newer methods of analysis and those which have not been previously covered in marine chemistry books (flame photometry, atomic absorption spectroscopy, and compleximetric titrations) are discussed, and problems of analysis, and treatment of data, are also considered. A chapter on water pollution, containing pertinent analysis procedures, is included. Each chapter begins with an introduction summarizing the chief methods available, and a review of relevant concepts and calculations is provided.

The information contained in this volume will be of interest to chemists, oceanographers, technicians, biologists, zoologists, geologists, and scientists in related fields concerned with water and its constituents.

C. V. R.

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### Iron Powder Metallurgy (Volume 3).—

*Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications.* Edited by Henry H. Hausner, Kempton H. Roll and Peter K. Johnson. (Plenum Press, New York), 1968. Pp. viii + 379.

Iron Powder Metallurgy provides an international cross-section of the work in this field and furnishes valuable information.

The volumes in this continuing series are devoted to presenting important information on all topics of interest to powder metallurgists. They are collections of articles and monographs, some new and some previously available

in relatively inaccessible reports and periodicals. Written by internationally known research workers, the material selected is carefully arranged according to topics to give a comprehensive survey of the field covered by each volume.

This book contains a collection of papers dealing with various aspects of iron powder metallurgy. It is divided into 20 chapters, which represent mostly reprints of previously published papers by authors from the United States, the United Kingdom, the Soviet Union, Japan, Sweden, and Germany. Some of these chapters contain already classified information on the subject, such as the chapter by J. C. Leadbeater *et al.*, or the chapter by O. H. Henry and J. J. Cordiano. The information given in this book concerns powder production, compacting methods, and the process of sintering. It mostly concerns pure iron, but some of the iron alloys, dense and porous iron parts and their characteristics, as well as some design problems are also covered.

C. V. R.

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### Comparative Biochemistry of the Flavonoids.

By J. H. Harborne. (Academic Press, London and New York), 1967. Pp. viii + 383. Price 90 sh./\$ 16.00.

This book presents a comprehensive account of the biochemistry of the water-soluble flavonoids which are, from the point-of-view of visual colour, most important pigments in plants. These pigments are the widely distributed anthocyanins, flavonols and flavones, and the less common flavanones, iso-flavones, chalcones and aurones.

The present volume under review has three main aims: (1) to provide an outline of their structural variability and a key to their identification, (2) to describe their natural distribution in some detail and draw attention to their potential systematic importance, and (3) to summarise what is known of their inheritance, biosynthesis, function and economic importance. The material presented here should be a useful implement to organic chemists, plant biochemists and taxonomists and to botanists in general.

The titles of the chapters contained in this book are listed below: The Anthocyanin-



Pigments; Flavone and Flavonol Pigments; The Minor Flavonoids; General Distribution of Flavonoids; Flavonoids of the Dicotyledons—The Archichlamydeae; The Flavonoids of the Sympetalae; Flavonoids of the Monocotyledoneae; Inheritance and Biosynthesis of Flavonoids in Plants; Function of Flavonoids; and Chemical Taxonomy of Flavonoids. C. V. R.

**Modern Aspects of Reflectance Spectroscopy—***Proceedings of the American Chemical Society Symposium on Reflectance Spectroscopy*, held in Chicago, Illinois, September 11-12, 1967. Edited by Wesley W. Wendlandt. (Plenum Press, New York), 1968. Pp. x + 254.

This volume contains all of the papers presented at the American Chemical Society Symposium on Reflectance Spectroscopy. The Symposium was presented under the sponsorship of the Division of Analytical Chemistry, and was held on September 11 and 12, 1967, at the 154th National Meeting of the American Chemical Society, Chicago, Illinois.

Although the technique of reflectance spectroscopy is not new, it has only been applied to problems of a chemical nature in the last decade or so. The instrumentation of this technique in the ultra-violet, visible, and near infrared spectral regions has been available for many years and research is being conducted to extend these techniques to the infrared and far infrared regions as well.

The twenty-one papers included in this volume contain the recent advances in the theory, application, and instrumentation in the field of reflectance spectroscopy. C. V. R.

**Space, Time and Relativity.** By Rolf Nevanlinna. Translated from the German by G. Reece. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London W. 1), 1968. Pp. 158. Price 28 sh.

The original book in German was based on lectures delivered by the author at the Universities of Helsinki and Zurich to students of all faculties. The author's aim has been to explain the basic ideas of space, time, and relativity in as simple a form as possible. Without sacrificing scientific accuracy he has largely succeeded in presenting the concepts

of space and time in lucid language, and developing against this background the fundamental ideas of relativity.

The subject-matter is dealt with in five chapters: Space; Time; Classical and Relativistic Kinematics; Classical and Relativistic Dynamics; and The General Theory of Relativity. The translator has added a number of exercises. A. S. G.

**Hand-book of Rock Gardening on the Hills.** By P. Kachroo. (Published by the Indian Council of Agricultural Research, Krishi Bhavan, Dr. Rajendra Prasad Road, New Delhi). Pp. 90. Price Rs. 5-20.

This booklet is intended for the amateur gardener interested in rock gardening. The first thirty pages give general hints on choosing sites, making artificial rocks, lay-outs, selection of plants, planting, and care. The remaining fifty pages are devoted to short descriptions of a number of suitable plants. The book is illustrated with a few half-tone and colour plates, and a number of text-figures. A. S. G.

#### Books Received

**Annual Review of Medicine** (Vol. 19). Edited by A. C. Degraff and W. P. Creger. (Annual Reviews, Inc., Palo Alto, Calif.), 1968. Pp. viii + 540. Price U.S.A. \$ 8.50.; elsewhere \$ 9.00.

**Fatty Acids and Their Industrial Applications.** Edited by E. S. Pattison. (Marcel Dekker, Inc., 95, Madison Avenue, New York 10016), 1968. Pp. xii + 390. Price \$ 8.00.

**Molecular Orbital Theories of Bonding in Organic Molecules.** By R. L. Flurry, Jr. (Marcel Dekker, Inc., New York 10016), 1968. Pp. x + 334. Price \$ 17.75.

**Catalysis Reviews** (Vol. 1). Edited by H. Heinemann. (Marcel Dekker, Inc., New York 10016), 1968. Pp. vii + 333. Price \$ 17.50.

**Chemistry and Physics of Carbon** (Vol. 3). Edited by P. L. Walker, Jr. (Marcel Dekker, Inc., New York 10016), 1968. Pp. xii + 449. Price \$ 22.75.

**The Structural Basis of Antibody Specificity.** By A. L. Crossberg and D. Pressman (W. A. Benjamin, Inc., One Park Avenue, New York 10016), 1968. Pp. xvii + 279. Price \$ 16.75.

**Advances in Chromatography** (Vol. 6). Edited by J. Calvin Giddings and Roy A. Keller. (Marcel Dekker, Inc., New York 10016).



# OCCURRENCE OF *HYPHOMICROBIUM* AND *CAULOBACTER* SPP. IN BORE-WELL WATER

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## INTRODUCTION

**P**AUCITY in the supply of protected water has necessitated examination in this laboratory of other water sources and one such source recently examined was the supply from a bore-well on this campus. While routine laboratory media have been found satisfactory for obtaining a general picture of microbial ecology of waters, their inadequacy for deriving a wider picture of the water microflora was ably demonstrated by Henrici several years ago.<sup>1</sup> Using the submerged slide technique he observed that quite a few bacteria that were not isolatable on routine laboratory media could be observed attached to the slides. He also drew attention to the various types of stalked bacteria occurring in water and provided valuable information on these species.<sup>2</sup>

With a view to study in great details such unusual forms of bacteria slides were suspended in the bore-well water stored in the laboratory. The slides were suspended by using a thin "iron" wire instead of rubber-covered copper wire ("Radio hook-up" wire) used by Henrici.<sup>1</sup> Incidental rusting of the wire, and consequential brown encrustation thereon and onto the slides thereafter, led to a thorough examination of the slides and the encrustations as well. A brief description of the various stalked bacteria observed on the slides and in cultures is presented in this communication.

## METHODS AND RESULTS

The water sample examined was drawn from a bore-well nearly 130 feet deep. The pH of the water was 7.9. Clean sterile slides tied with alcohol sterilised "iron" wires were kept immersed in approximately 4-litre volume of the bore-well water stored in a 5-litre flask by inserting the wires between the plug and the rim of the flask. The flask was placed in the dark at room temperature (25–30° C.).

On chemical analysis the composition of the "iron" wire turned out to be: Fe—91.56%, Mn—8.18%, Zn—trace.

In about 10 days, a portion of the wire under water gave clear indications of rust at dif-

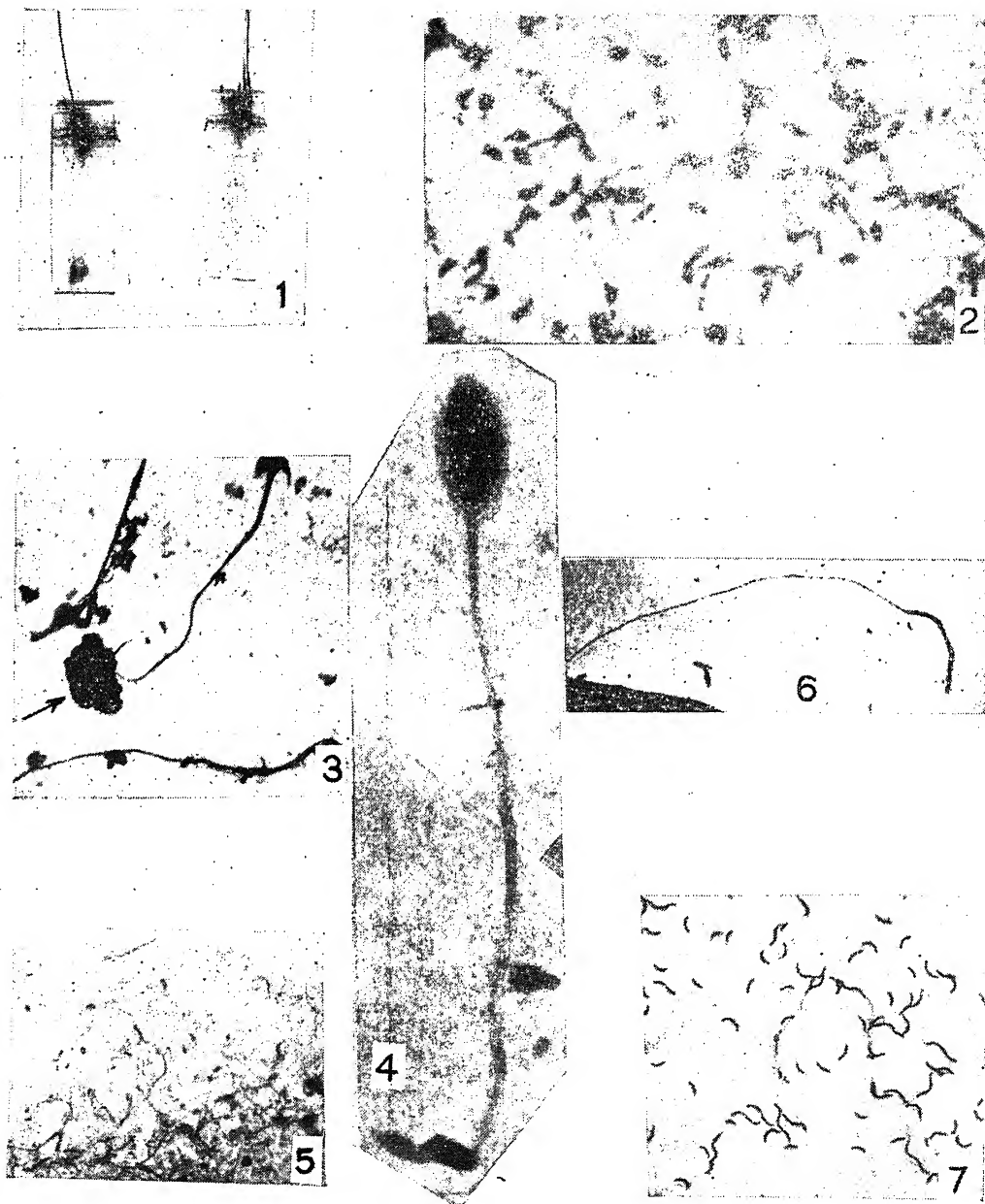
ferent points. Rusting was conspicuous at the water surface and where the wire was in contact with the slide. On prolonged incubation (about 15 to 20 days), the rust gradually spread all over the slide (Fig. 1). On simple staining with crystal violet (after either heat fixing or chemical fixing with Bouin's fluid), the slides revealed invariably the presence of stalked, budding—*Hyphomicrobium* cells in the phase contrast microscope. Sometimes the cells were found in clusters with repeated branching of stalks forming a network (Fig. 2). Occasionally some curved, stalked cells of *Caulobacter* were also observed. For photomicrographic work, the slides were treated with 5 to 10% tannic acid solution for 10 to 15 min. prior to staining with Hucker's crystal violet. The tannic acid treatment facilitated better resolution of the bacterial stalks.

A month long incubation resulted in the appearance on the wire at different points, of rusty nodules, 1–2 mm. in diameter. The nodules were generally soft, easily detachable and were amenable to easy breakage by mere agitation. They gave characteristic Prussian blue reaction for ferric ions when treated with a few drops of 5 N H<sub>2</sub>SO<sub>4</sub> and K<sub>4</sub>[Fe(CN)<sub>6</sub>] solution. A drop of the broken nodular material was put on the copper grid for examination of the air-dried specimen in the 100 kV electron microscope and showed the presence of a few unusual types of "stalked cells" (Fig. 3). The arrow in Fig. 3 points presumably to a lump of the iron material enclosing a cell joining the bifurcated stalk. Some typical *Hyphomicrobium* cells were also observed. Such a cell having two bud-like structures attached to the stalk is shown in Fig. 4 in a reconstructed form. Since *Hyphomicrobium* is known to be pleomorphic and gives rise to many forms,<sup>3,4</sup> it would seem that the "stalked cells" depicted in Fig. 3 represent only the pleomorphic forms of *Hyphomicrobium*. This observation called for a further enquiry and prompted an enrichment of *Hyphomicrobium* spp. and was achieved in the following way:—

The rusted portion of the wire or a nodule was cut out and inoculated into (1) a 250 ml. flask containing 150 ml. of "337" basal salt

medium of Hirsch and Conti<sup>4,5</sup> with filter-sterilised methylamine-HCl, and (2) in a 250 ml. flask filled with 150 ml. autoclaved bore-well water. Both the flasks were incubated at 30° C. for two weeks.

(1) *Enrichment in "337" Medium.*—This medium showed a pellicle formation on the surface which on examination revealed to be that of *Hyphomicrobium* cells mixed with many other types of bacteria. When sufficient



FIGS. 1-7. Fig. 1. Photograph of the slides tied to "iron" wires showing rust encrustation. Fig. 2. Phase contrast, crystal violet stain,  $\times$  about 2,000. Fig. 3. Electron micrograph,  $\times$  about 4,000. Fig. 4. Electron micrograph,  $\times$  about 20,000. Fig. 5. Phase contrast, crystal violet stain,  $\times$  about 1,000. Fig. 6. Electron micrograph,  $\times$  about 1,575. Fig. 7. Phase contrast, crystal violet stain,  $\times$  about 1,100.

*Hyphomicrobium* cells got enriched in the methylamine-HCl medium, they were isolated on the plate containing the same medium solidified with agar after about a week's incubation at 30° C. In this way a few more strains of *Hyphomicrobium* were successfully isolated from the bore-well as well as two other water sources for a systematic study.

(2) *Enrichment in Autoclaved Bore-Well Water*.—This was attempted with the expectation that the wire would show progressive corrosion and might result in the continued stimulation of the growth of *Hyphomicrobium* spp. It was also hoped that the limiting nutritional conditions of the water medium might suppress the growth of other associated micro-organisms and permit almost exclusive growth of the desired species.

As long as four months incubation, however, did not show any remarkable progress in corrosion, though a flocculent growth at the bottom and a thin film on the surface became clearly visible. Both the growths were found to be that of the stalked bacteria. The contents were stained after shaking well. The preponderance of the stalked bacteria in this can be witnessed from Fig. 5. Certain elongated, curved bacteria with long stalks were also observed. An electron micrograph of such a stalked bacterium is shown in Fig. 6. The organism appeared to be a *Caulobacter* species; an attempt was therefore made to isolate it by the method described by Stove.<sup>6</sup> Surprisingly several types of *Caulobacter* appeared on the plate from this single enrichment culture flask. Detailed study on them will be published elsewhere.

A typical vibrioid *Caulobacter* isolate possibly related to the one in Fig. 6 is shown in Fig. 7. The undisturbed storage conditions of the autoclaved bore-well water medium must have resulted in the enrichment of *Caulobacter* spp. associated with the rusted wire which

perhaps serves as a support for their attachment. Likewise the flocculent material from the bore-well water medium gave rise to the growth of *Hyphomicrobium* on methylamine-HCl agar plate.

The deposition or accumulation of iron and manganese by *Hyphomicrobium* and related spp. has been reported by several workers.<sup>7-9</sup> Tyler and Marshall<sup>3,10-11</sup> described manganese depositing *Hyphomicrobium* spp. from water pipe-lines. Recently, Hirsch<sup>12</sup> reported epicellular deposition of iron by *Hyphomicrobium* spp. It is not surprising therefore that *Hyphomicrobium* was associated with the rust of the wire containing both iron and manganese and both the metals might have enriched these species. It must however be mentioned that the growth of *Hyphomicrobium* is probably not chemolithotrophic as it can occur in the absence of oxidizable iron as well. Its association with the iron or manganese environments is however more frequent and perhaps more significant though we have at present no unequivocal explanation for this phenomenon. It can be said that the pipe-line in the source might have facilitated a preliminary enrichment of these organisms in the bore-well water.

1. Henrici, A. T., *J. Bacteriol.*, 1933, **25**, 277.
2. — and Johnson, D. E., *Ibid.*, 1935, **30**, 61.
3. Tyler, P. A. and Marshall, K. C., *Ibid.*, 1967, **93**, 1132.
4. Hirsch, P. and Conti, S. F., *Arch. Mikrobiol.*, 1964, **48**, 339.
5. — and —, *Ibid.*, 1964, **48**, 358.
6. Stove, J. L., *Anreicherungskultur und Mutantenauslese, Symposium in Göttingen*, 1964, Gustav Fisher Verlag-Stuttgart, 1965, p. 95.
7. Aristovskaya, T. V., *Dokl. Akad. Nauk SSSR (Transl.)*, 1961, **136**, 954.
8. Zavarzin, G. A., *Z. allg. Mikrobiol.*, 1964, **4**, 390.
9. Perfil'ev, B. V. and Gabe, D. R., *Nauki (Moscow)*, 1964 (Transl. Consultants Bureau, New York, 1965).
10. Tyler, P. A. and Marshall, K. C., *Arch. Mikrobiol.*, 1967, **56**, 344.
11. — and —, *Antonie van Leeuwenhoek*, 1967, **23**, 171.
12. Hirsch, P., *Arch. Mikrobiol.*, 1968, **60**, 201.

## A NOTE ON THE DERIVATION OF MAGNETIC LATTICES

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IT is well known that crystals are classified into 230 space groups belonging to one or the other of the 14 Bravais lattices and the 32 crystal classes. To account for the magnetic properties of crystals it was found necessary to introduce the time reversal operation  $\mathcal{R}$ . The introduction of this new operation increases the number of the point groups from 32 to 122, the Bravais lattices from 14 to 36 and the space groups from 230 to 1651. The additional double-coloured magnetic Bravais lattices have been derived by Zamorzaev<sup>1</sup> using a mathematical method and also by Belov, Neronova and Smirnova<sup>2</sup> using the fundamental property of coloured translations while Villain's<sup>3</sup> approach in his paper on magnetic lattices has been quite different. Employing the concept of a semi-direct product (Lomont,<sup>4</sup> and Altmann<sup>5</sup>) of two groups, Opechowski and Guccione<sup>6</sup> have shown that only 22 distinct magnetic double-coloured Bravais lattices exist. Recently Bhagavantam and Pantulu<sup>7</sup> deduced them as variants of the translational groups. In this note it is proposed to establish a close connection between the magnetic Bravais lattices and the stars of the wave vectors of the symmorphic space groups (point space groups) given in the *International Tables for X-ray Crystallography*.<sup>8</sup> It is shown here how some of the double-coloured magnetic Bravais lattices can be straightaway read off from the stars of the symmorphic space groups and from the definition of the semi-direct product of two groups the other dichromatic magnetic Bravais lattices are related to the stars of the appropriate point space groups.

It has been shown by the authors<sup>9</sup> that the non-equivalent alternating representations of a group  $G$  induce the distinct magnetic variants of  $G$ . If  $G$  is now taken as a translational group  $T$  corresponding to a Bravais lattice, the total symmetric representation of  $T$  will induce the conventional (uncoloured) Bravais lattice. The other real one-dimensional irreducible representations (alternating representations) of  $T$  induce the double-coloured magnetic Bravais lattices, which are otherwise known as the magnetic variants of the Bravais lattices.

Two magnetic double-coloured Bravais lattices  $T_{m1}$  and  $T_{m2}$  of respective magnetic

holohedries  $H_1$  and  $H_2$  are said<sup>6</sup> to belong to the same magnetic Bravais class (which are hereafter designated as equivalent) if (i) the semi-direct product of  $T_{m1}$  and  $H_1$  is isomorphous to that of  $T_{m2}$  and  $H_2$  and (ii) the uncoloured elements of the former semi-direct product under this isomorphism correspond to those of the latter. This definition will be applied in obtaining the magnetic variants of the Bravais lattices in two and three dimensions from the alternating representations of the appropriate translational group.

For the derivation of the magnetic variants of the lattices in two dimensions, it is sufficient<sup>9</sup> to consider the translational group generated by the elements  $T_x$  and  $T_y$  such that  $T_x^2 = T_y^2 = E$  (identity). Thus the translational group in two dimensions will have 4 real one-dimensional representations. Each alternating representation of the translational group induces a double-coloured magnetic lattice and is associated with a non-

zero wave vector  $\vec{k}$  ( $k_x, k_y$ ) of the reciprocal space, since the generating elements  $T_x$  and  $T_y$  can be represented respectively by  $\exp. (2\pi i k_x)$  and  $\exp. (2\pi i k_y)$  (Koster<sup>10</sup>). The character table of the translational group in two dimensions is

Wave vector	E	$T_x$	$T_y$	$T_x T_y$	Magnetic Bravais lattice
(0, 0)	1	1	1	1	..
(0, $\frac{1}{2}$ )	1	1	-1	-1	$T_{m1}$
( $\frac{1}{2}$ , 0)	1	-1	1	-1	$T_{m2}$
( $\frac{1}{2}$ , $\frac{1}{2}$ )	1	-1	-1	1	$T_{m3}$

The magnetic variants of the Bravais lattices in two dimensions will be now enumerated and described in terms of the stars of the symmorphic plane space groups.

(1) *Monoclinic*.—The magnetic holohedries of the three magnetic lattices  $T_{m1}$ ,  $T_{m2}$  and  $T_{m3}$  are the same and consist of the identity  $E$  and the complementary symmetry operation  $i$  (Zheludev<sup>11</sup>). From the definition of the semi-direct product it may be seen that  $T_{m1}$ ,  $T_{m2}$  and  $T_{m3}$  are all equivalent. Hence only one distinct variant of the monoclinic lattice exists and the three wave vectors (0,  $\frac{1}{2}$ ), ( $\frac{1}{2}$ , 0) and ( $\frac{1}{2}$ ,  $\frac{1}{2}$ ) may be regarded as equivalent,

These three wave vectors are contained in the stars *b*, *c* and *d* respectively of the two-dimensional monoclinic primitive point space group  $p2$  (p. 58\*) which has the holohedral symmetry of the system. Thus the stars *b*, *c* and *d* of the space group are equivalent and any one of them can be taken to induce the magnetic variant of the lattice.

(2) *Orthorhombic Primitive*.—To enumerate the distinct magnetic variants of this lattice, the symmorphic space group  $pm\bar{m}$  (p. 61) is considered whose underlying point group has the orthorhombic holohedry ( $D_{2h}$ ). The magnetic holohedry<sup>1,2</sup> of the magnetic lattice  $T_{m1}$  is  $E$ ,  $C_2$ ,  $\sigma_x$ ,  $\sigma_y$  and that of  $T_{m2}$  is  $E$ ,  $C_2$ ,  $\sigma_x$ ,  $\sigma_y$ . But the magnetic holohedries of  $T_{m1}$  and  $T_{m2}$  are isomorphous and different from that of  $T_{m3}$  which consists of  $E$ ,  $C_2$ ,  $\sigma_x$ ,  $\sigma_y$ . It can be shown from the idea of the semi-direct product that  $T_{m1}$  is equivalent to  $T_{m2}$  but different from  $T_{m3}$ . Thus the stars *b* and *c* of the space group  $pm\bar{m}$  are equivalent and different from the star *d*. Hence there are only two magnetic variants of the orthorhombic primitive lattice.

In this way the magnetic variants of the other Bravais lattices for the remaining systems can be obtained by noting that (i) only those symmorphic space groups whose underlying point group is the holohedry of the system have to be taken into account, (ii) components of the wave vectors in the stars of the symmorphic space groups, which are given with respect to the crystallographic axes in the case of the derived lattices, should be transformed to the Bravais axes to decide equivalence among the stars, (iii) if two or more of the wave vectors  $(0, \frac{1}{2})$ ,  $(\frac{1}{2}, 0)$  and  $(\frac{1}{2}, \frac{1}{2})$  occur in a star of a point space group, then the corresponding alternating representations of the translational group will get clubbed together so that they can be regarded as degenerate and (iv) only those stars containing any one of the three wave vectors need alone be considered.

(3) *Orthorhombic Derived*.—The magnetic variant of this lattice is due to the star *b* of the space group  $cm\bar{m}$  (p. 64).

(4) *Tetragonal*.—The star *b* of the space group  $p4m$  (p. 66) gives rise to the magnetic variant.

(5) *Hexagonal*.—No variant exists in this case since the wave vectors  $(0, \frac{1}{2})$ ,  $(\frac{1}{2}, 0)$  and

$(\frac{1}{2}, \frac{1}{2})$  occur in the star *c* of the space group  $p6m$  (p. 72).

### THREE-DIMENSIONAL MAGNETIC BRAVAIS LATTICES

The distinct magnetic variants corresponding to each one of the 14 conventional Bravais lattices of the 7 crystal systems are obtained below on the lines similar to those adopted in the derivation of the magnetic variants of the two-dimensional lattices described earlier. The character table of the translational group in three dimensions, generated by the elements  $T_x$ ,  $T_y$  and  $T_z$  such that  $T_x^2 = T_y^2 = T_z^2 = E$  (identity operation), is given below:

Wave vector	$E$	$T_x$	$T_y$	$T_z$	$T_x T_y$	$T_x T_z$	$T_y T_z$	$T_x T_y T_z$	Magnetic lattice
$(0, 0, 0)$	1	1	1	1	1	1	1	1	..
$(\frac{1}{2}, 0, 0)$	1	-1	1	1	-1	-1	1	-1	$T_{m1}$
$(0, \frac{1}{2}, 0)$	1	1	-1	1	-1	1	-1	-1	$T_{m2}$
$(0, 0, \frac{1}{2})$	1	1	1	-1	1	-1	-1	-1	$T_{m3}$
$(\frac{1}{2}, \frac{1}{2}, 0)$	1	-1	-1	1	1	-1	-1	1	$T_{m4}$
$(\frac{1}{2}, 0, \frac{1}{2})$	1	-1	1	-1	-1	1	-1	1	$T_{m5}$
$(0, \frac{1}{2}, \frac{1}{2})$	1	1	-1	-1	-1	-1	1	1	$T_{m6}$
$(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$	1	-1	-1	-1	1	1	1	-1	$T_{m7}$

(1) *Triclinic*.—The magnetic holohedry consisting of the elements  $E$  and  $i$  is the same for all the seven magnetic lattices  $T_{m1}$ ,  $T_{m2}$ , ...,  $T_{m7}$ . Thus all the seven alternating representations of the translational group in this case are equivalent giving rise to only one magnetic variant of the lattice. So in the symmorphic

space group  $P\bar{1}$  (p. 75), the stars *b*, *c*, *d*, *e*, *f*, *g* and *h* are all equivalent and the magnetic variant can be taken to be due to any one of these seven stars.

(2) *Monoclinic Primitive*.—The point space group to be considered is  $P2/m$  (p. 91). The magnetic holohedries of  $T_{m4}$ ,  $T_{m6}$  and  $T_{m7}$  are isomorphous and those of  $T_{m1}$ ,  $T_{m3}$  and  $T_{m5}$  are also isomorphous. Thus the three magnetic variants will be due to the stars *d* (or *c* or *g*), *e* (or *f* or *h*) and *b*.

(3) *Monoclinic Side-Centered*.—The point space group  $C2/m$  (p. 95) is chosen. The wave vectors  $(\frac{1}{2}, 0, 0)$  and  $(0, \frac{1}{2}, 0)$  occur in the star *e* while  $(\frac{1}{2}, 0, \frac{1}{2})$  and  $(0, \frac{1}{2}, \frac{1}{2})$  are present in the star *f*. From the definition of the semi-direct product, the magnetic lattices  $T_{m3}$  and  $T_{m7}$  can be shown to be equivalent. Hence the magnetic variants of the lattice are due to the stars *b* and *c* (or *d*).

(4) *Orthorhombic Primitive*.—The space group to be selected is  $Pnmm$  (p. 133). The

\* Page numbers given in brackets against the space groups refer to the pages in the *International Tables for X-ray Crystallography*, 1952.

stars ( $e, b, c$ ) are equivalent and so do the stars ( $f, g, d$ ). The stars  $h, e$  (or  $b$  or  $c$ ) and  $f$  (or  $g$  or  $d$ ) will give rise to the three variants of the lattice.

(5) *Orthorhombic Body-Centered*.—The symmorphic space group  $Immm$  (p. 163) is to be taken. Its reciprocal space group is  $Fmmm$  (p. 159). The magnetic variants of the body-centered lattice will be now associated with the wave vectors of  $Fmmm$ . On transformation of the components of the wave vectors of  $Fmmm$  from the crystallographic axes to the Bravais axes it is found that the wave vectors  $(0, 0, \frac{1}{2})$  and  $(\frac{1}{2}, \frac{1}{2}, 0)$  belong to the star  $e$ ,  $(0, \frac{1}{2}, 0)$  and  $(\frac{1}{2}, 0, \frac{1}{2})$  to the star  $d$  and  $(\frac{1}{2}, 0, 0)$  and  $(0, \frac{1}{2}, \frac{1}{2})$  to the star  $c$  of the space group  $Fmmm$ . Thus the only variant of the body-centered orthorhombic lattice is due to the star  $b$   $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$  of  $Fmmm$ .

(6) *Orthorhombic Face-Centered*.—The required space group is  $Fmmm$  (p. 159). The reciprocal symmorphic space group is  $Immm$  (p. 163). Effecting the transformation to the Bravais axes, the wave vectors  $(\frac{1}{2}, 0, 0)$ ,  $(0, \frac{1}{2}, 0)$ ,  $(0, 0, \frac{1}{2})$  and  $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$  belong to the star  $k$  of  $Immm$ . It can be shown on lines similar to the magnetic variants of the triclinic lattice that the stars  $b, c$  and  $d$  of  $Immm$  are all equivalent so that only one magnetic variant is permitted.

(7) *Orthorhombic Side-Centered*.—The point space group to be regarded is  $Cmmm$  (p. 154). The wave vectors  $(\frac{1}{2}, 0, \frac{1}{2})$  and  $(0, \frac{1}{2}, \frac{1}{2})$  belong to the star  $f$  and  $(\frac{1}{2}, 0, 0)$  and  $(0, \frac{1}{2}, 0)$  belong to the star  $e$ . Thus the three variants are due to the stars  $b, c$  and  $d$ .

(8) *Tetragonal Primitive*.—The space group to be chosen is  $P4/mmm$  (p. 213). The three magnetic variants of this lattice are due to the stars  $b, c$  and  $d$  as can be easily seen from the *International Tables*.

(9) *Tetragonal Body-Centered*.—In this case the space group to be dealt with is  $I4/mmm$  (p. 241). The wave vectors  $(\frac{1}{2}, 0, 0)$ ,  $(0, \frac{1}{2}, 0)$ ,  $(0, 0, \frac{1}{2})$  and  $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$  correspond to the star  $f$  and the wave vectors  $(\frac{1}{2}, 0, \frac{1}{2})$ , and  $(0, \frac{1}{2}, \frac{1}{2})$  belong to the star  $c$ . Hence the only variant is due to the star  $b$ .

(10) *Rhombohedral (Trigonal)*.—The space group under question is  $P31m$  (p. 268). The variant of the lattice is due to the star  $b$  while the remaining wave vectors belong to the stars  $g$  and  $f$  of the space group.

(11) *Hexagonal*.—It can be easily read off from the *International Tables* that the only permitted variant in this case is due to the star  $b$  of the space group  $P6/mmm$  (p. 298).

(12) *Cubic Primitive*.—The resulting magnetic variant of the lattice is due to the star  $b$  of the space group  $Pm3m$  (p. 330).

(13) *Cubic Body-Centered*.—The space group considered here is  $Im3m$  (p. 344) whose reciprocal symmorphic space group is  $Fm3m$  (p. 338) and the magnetic variant of the cubic body-centered lattice is due to the star  $b$  of  $Fm3m$ .

(14) *Cubic Face-Centered*.—Since the reciprocal point space group  $Im3m$  (p. 344) of the space group  $Fm3m$  (p. 338) does not contain a star which consists of only one of the seven wave vectors  $(0, 0, \frac{1}{2})$ ,  $(\frac{1}{2}, 0, 0)$ , etc., there is no magnetic variant of the cubic face-centered lattice.

The magnetic variants of a Bravais lattice are described in terms of the stars of a symmorphic space group which belongs to the Bravais lattice and whose underlying point group symmetry is the holohedry of the system and those of the derived lattices are expressed in terms of the stars of the reciprocal symmorphic space groups. It may be further noted that the choice of the stars may be restricted to those that contain only one wave vector which necessarily has the holohedral symmetry of the system. Other stars having more than one wave vector need not be considered in the derivation of the magnetic lattices as they possess lower symmetry.

The novelty in this investigation paves the way for the construction of the Shubnikov space groups from the representation theory of the conventional space groups.

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1. Zamorzaev, A. M., *Soviet Phys. Cryst.*, 1957, **2**, 10.
2. Belov, N. V., Neronova, N. N. and Smirnova, T. S., *Ibid.*, 1957, **2**, 311.
3. Villain, J., *Phys. Chem. Solids*, 1959, **11**, 303.
4. Lomont, J. S., *Applications of Finite Groups*, Academic Press New York, 1959, p. 29.
5. Altmann, S. L., *Rev. Mod. Phys.*, 1963, **35**, 641.
6. Opechowski, W. and Guccione, R., *Magnetism*, Academic Press, Oxford, 1965, **2A**, pp. 105.
7. Bhagavantam, S. and Pantulu, P. V., *Proc. Ind. Acad. Sci.*, 1966, **63**, 391.
8. Norman, F. M., Henry and Lonsdale, K., *International Tables for X-ray Crystallography*, 1952, **1**.
9. Krishnamurty, T. S. G. and Gopalakrishnamurty, P., A paper on "Magnetic Symmetry Groups," communicated to *Acta Cryst.*, 1968.
10. Koster, G. F., *Solid State Physics*, Academic Press, 1957, **5**, 173.
11. Zheludev, I. S., *Soviet Phys. Crystall.*, 1960, **5**, 328.
12. Bhagavantam, S., *Crystal Symmetry and Physical Properties*, Academic Press London, 1966, p. 51.

# ALLOMORPHIC GROWTH PATTERNS IN RELATION TO SEX-LIMITED POLYMORPHISM IN SOME MYCOPHAGOUS TUBULIFERA (THYSANOPTERA)

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THE occurrence of diverse allomorphic growth patterns and the consequent structural complexities limited mostly to the males of species exhibiting oedemerism and gynaeoidism, with a reasonably graded series between them has been reported in several mycophagous species (Ananthakrishnan 1961, 1965, 1967, 1968). On the basis of the degree of complexity these patterns may be broadly designated (a) simple, unitary or monophasic involving minimal effects on the morphs, with utmost an enlargement of the forefemora and foretarsal tooth as in such species as *Dichothrips indicus* Ananthakrishnan, *Nesothrips indicus* Ananthakrishnan, *Nesothrips robustus* Ananthakrishnan, *Pygothrips amplius* Faure, (b) multiple or polyphasic involving not only pronounced development of several parts and varying with species or species groups, but also resulting in the development of additional structures in the oedymorous males not known in the normal males of the species concerned, and the total loss or lack of several secondary sexual characters in the minimum on gynaeoid males, as in *Ecacanthothrips sanguineus* Bagnall, *Tiarothrips subramanii* (Ramakrishna), *Kleothrips agama* Priesner, *Nesothrips falcatus* Ananthakrishnan, *Sophiothrips parviceps* (Faure), etc. Again species inhabiting the same niche may show differential patterns as in the case of the different species of *Nesothrips*. Similarly apterous and brachypterous males are prone to show more pronounced oedemerism than their macropterous counterparts, as is evident in such species as *Hoplothrips fungosus* (Moulton), *Sophiothrips parviceps* (Faure) and *Carathrips orientalis* Ananthakrishnan. Recent observations on such mycophagous species as *Polyphemothrips cracens* Ananthakrishnan, *Symphiothrips associatus* Ananthakrishnan, *Pygothrips amplius*, *Hoplandrothrips natalensis* (Trybom), *Nesothrips acuticornis* (Hood), *Percnothrips turbinatus* Ananthakrishnan, *Priesneriana kabandha* (Ramakrishna) and *Hoplothrips orientalis* Ananthakrishnan have revealed striking differences from the basic pattern of the normal males of these species, introducing problems with regard to their proper determination. That the patterns are different and variable are also

confirmed by the allomorphic indices of the various species.

*Polyphemothrips cracens* and *Symphiothrips associatus* are invariably associated on fungus infested twigs and dried leaves and examination of a reasonably good series of males of both species indicate clearly that while the effects of oedemerism in *S. associatus* are unitary, involving only the size of the forefemora (80-160  $\mu$  wide, 176-336  $\mu$  long), in *P. cracens* the effects are considerable. While the ratio of the forefemoral width in the gynaeoid and oedymorous males of both species is 1:2, *P. cracens* exhibits striking differences in (1) the excessive forefemoral elongation, (2) the development of basal and apical forefemoral teeth, (3) development of conspicuous foretibial tooth at apex, (4) very characteristic tooth-like prolongation posteriorly on the outer margin of the forefemora. The gynaeoid males of both the species however are almost similar, in having unspecialised forefemora resulting from the apparent loss of the excessively pronounced secondary sexual characters, which express themselves strongly only in the oedymorous males. A feature of interest is that in spite of the excessive specialisation of the forelegs of the oedymorous males in *P. cracens*, there is no corresponding enlargement of the foretarsal tooth (32-48  $\mu$ ) unlike as was earlier reported in *N. falcatus* Ananthakrishnan (1967) where the foretarsal tooth enlarges beyond proportions. However another species, *Hoplandrothrips natalensis* shows the oedymorous males with excessively long postoculars, anteroangulars and midlateral prothoracic setae, as was reported in *N. falcatus*. *Pygothrips amplius* Faure, the males of which were discovered for the first time in good numbers, represents a remarkable example of a species with unitary effects, showing excessive enlargement of the forefemora (length 128-272  $\mu$ , width 88-160  $\mu$ ) accompanied by enlargement of the prothorax, but without any resulting specialisation of any of the other parts or the development of accessory structures.

While *Percnothrips turbinatus*, *Pygothrips amplius* and *Priesneriana kabandha* appear to fall within the same unitary type of allomorphic growth pattern, the oedymorous males developing a distinct concavity on the inner side



of the forefemora, the species *Hoplothrips fungosus*, *Sophiothrips parviceps* and *Hoplo-*

While all the above examples discussed refer to male polymorphism, only a solitary instance

TABLE I  
Allomorphic indices of some mycophagous Tubulifera (males)

Species	Index HL/FL		HW/FW		TL/FL	
	Gynaeoid	Oedymorous	Gynaeoid	Oedymorous	Gynaeoid	Oedymorous
<i>Polyphemothrips cracens</i>	.. 1.1	0.8	1.00	1.25	0.65	0.45
<i>Symphiothrips associatus</i>	.. 1.25	0.85	2.3	1.5	0.6	0.45
<i>Sophiothrips parviceps</i>	.. 0.7	0.4	1.75	1.75	0.6	0.4
<i>Hoplothrips fungosus</i>	.. 0.9	0.45	1.4	1.00	0.6	0.4
<i>Hoplothrips orientalis</i>	.. 1.2	0.7	2.00	1.00	0.8	0.45
<i>Eucanthothrips sanguineus</i>	.. 1.2	0.8	1.9	0.8	0.8	0.65
<i>Kieiothrips agama</i>	.. 1.5	1.00	1.45	0.45	0.9	0.8
<i>Pygothrips amplus</i>	.. 0.6	0.7	1.7	1.25	0.4	0.5
<i>Priesneriana kabandha</i>	.. 1.1	1.00	2.2	1.7	0.75	0.6

*thrips orientalis* are distinctly polyphasic with varied patterns but with one uniformity, viz., all of them have highly elongate forefemora and short foretibia with prothorax highly enlarged in the oedymorous males. In *C. orientalis* the presence of a short, but distinct anteocular projection characteristic of the brachypterous females and males—and particularly in oedymorous males—and head with angular eyes in the brachypterous females and males, are hardly recognisable in the macropterous counterparts. Again the maximum or minimum effects of oedymorphism in so far as has been studied by the author ranges between *Nesothrips acuticornis* and *Nesothrips falcatus* where both are polyphasic, but with *N. acuticornis* showing only a lateral mesothoracic process in the oedymorous males apart from the usual enlargement of the forelegs, while *N. falcatus* shows the maximum effects of polyphasism, the oedymorous males developing several extra structures like stout, curved spines on the coxae and femora, the foretibial teeth, the excessively enlarged foretarsal tooth, the highly elongate anteroangulars, and the development of a metanotal pterothoracic tongue-like process.

In the assessment of allomorphosis or allomorphic growth patterns, three indices appear essential for species comparison in relation to growth diversity. These indices are referred to in this work as HW/FW, HL/FL, TL/FL to denote head width/forefemoral width, head length/forefemoral length, foretibial length/forefemoral length respectively. It is only where there is lack of specialisation of the forelegs especially the foretarsus, there is very close similarity between the two sexes; but in all the mycophagous species discussed, not only are the allometric indices substantially different in the two sexes, but also very much different in the two extreme individuals—the gynaeoid and oedymorous males.

of a mycophagous species has been noted by the author where major and minor females occur with striking differences between them [also seen in the gall species *Arrhenothrips acuminatus* Ananthakrishnan (1968)]. *Plectrothrips corticinus* Priesner, a new record to the Indian region and hitherto known only from the Neotropical region, is an interesting example in view of the striking differences between the major and minor females emphasising the need for a knowledge of the various morphs for correct species determination. Particular mention may be made of the following significant features in this species between the two forms: (a) Postoculars in major females more than twice as long, (b) Prothorax in major females 1.5 times as long and width at posterior margin 1.8 times as long, (c) Epimerals almost twice as long, (d) Forefemora nearly twice as long, (e) Development of a distinct foretibial tubercle, absent in minor females.

In view of the set patterns of differentiation accompanying the phenomenon of oedymorphism in different species, it is evident that there may be a pattern determining set of genes in the males, the action of which may be suppressed in the gynaeoid males or triggered in the oedymorous males. Further studies relating to the various patterns in several other species are in progress.

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1. Ananthakrishnan, T. N., *Proc. Biol. Soc. Wash.*, 1961, **74**, 275.
2. —, *Bull. Ent.*, 1963, **6**, 57.
3. —, *Bull. Nat. Inst. Sci. India*, 1967, **34**, 371.
4. —, *Curr. Sci.*, 1967, **22**, 610.
5. —, *Indian J. Ent.*, 1967, **29**, 61.
6. —, *Ann. Soc. Ent. Franc.*, N.S (In press).
7. —, *Indian Forester*, 1968 (In press).
8. —, *Senckenb. Biol. Frankfurt*, 1968 (In press).



## LETTERS TO THE EDITOR

### RELATIVE MASS IN WORLD MODELS

It is well known that the static form of de Sitter's solution

$$ds^2 = \left(1 - \frac{r^2}{R^2}\right) dt^2 - \left(1 - \frac{r^2}{R^2}\right)^{-1} dr^2 - r^2 (d\theta^2 + \sin^2\theta d\phi^2) \quad (1)$$

where  $R^2 = 3/\lambda$ ,  $\lambda$  being the cosmological constant, was originally described as a universe in which there is motion but no matter. Following Professor Narlikar's<sup>1</sup> recent communication one can however observe that in this model empty of matter the relation between relative mass  $m$  and proper mass  $m_0$  is

$$m = m_0 \frac{dt}{ds} = m_0 \left(1 - \frac{r^2}{R^2}\right)^{-1/2} \quad (2)$$

if  $m_0$  is initially at rest at  $r=0$ . As the particle recedes under cosmical repulsion a stage can come when  $r/R$  is approximately unity, say,  $1-\epsilon$  where  $m = m_0/2\epsilon$  if  $\epsilon^2$  is neglected.  $m$  becomes very large. The increase in energy  $(m - m_0)c^2$  is entirely a field phenomenon. One can see that the increase in  $m$  is only  $m_0/3$  when  $r/R$  is 0.5. The real rise occurs only when  $r/R$  approaches unity. It shows how masses which are originally small can assume large values as the recession progresses. The phenomenon does not seem to have attracted attention before. The result is to be contrasted with what happens in an expanding universe. If we start with the metric

$$ds^2 = dt^2 - R^2(t) \left(1 + \frac{kr^2}{4}\right) (dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2) \quad (3)$$

$$k = \pm 1, 0$$

the corresponding result is

$$m^2 - m_0^2 = m_0^2 \frac{a}{R^2}, \quad (a \text{ being a constant}) \quad (4)$$

as has been pointed out by Professor Narlikar. Here, if initially the particle is at rest  $a=0$  and  $m=m_0$  always. But if initially the particle has some velocity so that there is a relative mass  $m(t_0) = \bar{m}_0$  at  $t=t_0$ , the relative

mass  $m(t) = \bar{m}$  is given by

$$\left(\frac{\bar{m}}{m_0}\right)^2 = 1 + \left(\frac{R_0}{R}\right)^2 \left[\left(\frac{\bar{m}_0}{m_0}\right)^2 - 1\right]. \quad (5)$$

This shows that in an expanding universe the relative mass of a moving particle continues to diminish. Thus in this case the recession is not accompanied by an increase in the relative mass as in the other case.

In the latter case the slow variation of the relative mass can be shown to be a local cosmical phenomenon throwing light on the cosmical pressure and density of the model through

$$\left. \begin{aligned} 8\pi p &= \frac{\beta}{R^4} \\ 8\pi \rho &= \frac{\alpha}{R^3} + \frac{3\beta}{R^4} \end{aligned} \right\} \quad (6)$$

$$R^2 = R_0^2 \left[\left(\frac{\bar{m}}{m_0}\right)^2 - 1\right] \left[\left(\frac{\bar{m}_0}{m_0}\right)^2 - 1\right]^{-1} \quad (7)$$

where  $\alpha$  and  $\beta$  are constants (Tolman<sup>2</sup>).

To the extent to which the geodesic motion governs the matter and motion of a celestial body, its changing relative mass can be said to be a guide to the cosmical conditions of the world model such as  $R$ ,  $p$  and  $\rho$  as shown in the formulæ given above. It must be noted that although these formulæ give the connection between  $p$ ,  $\rho$ ,  $\bar{m}$  and  $R$  Mach's principle is not strictly fulfilled inasmuch as there is no accounting of  $m_0$  itself in terms of the rest of the universe as in the Hoyle-Narlikar theory of gravitation.

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1. Narlikar, V. V., "Relative mass in general relativity," *Curr. Sci.*, 1968, 37, 281.
2. Tolman, R. C., *Relativity Thermodynamics and Cosmology*, Oxford, 1934, p. 408.

### COMPLEXES OF IODINE WITH AMIDES AND THEIR SPECTRA

THE spectroscopic studies of intermolecular associations in primary and secondary amides have been extensively investigated.<sup>1-6</sup> Tsubomura *et al.*<sup>7</sup> have made the spectrophotometric studies of solutions of iodine with acetamide and N, N-dimethylformamide. We report in this note the spectral studies in regard to the iodine absorption in presence of N,N-dimethylacetamide and N,N-diphenylacetamide.

As non-polar solvents like carbontetrachloride and *n*-heptane dissolve small amounts of amides, dichloromethane was chosen as a solvent as has been done by the earlier workers.<sup>7</sup> The absorption spectra of iodine in solutions of dichloromethane and in the presence of the amides were recorded by Unicam 700 double beam spectrophotometer in the region 550  $m\mu$  to 300  $m\mu$  using quartz matched cells of 1 cm. thickness. The concentration of iodine used in dichloromethane was 0.0005 molar and the concentration of the amides used with the iodine is of the order of 0.6 molar. The spectra were recorded with (i) iodine in dichloromethane in the sample beam with dichloromethane in the reference beam and (ii) iodine in dichloromethane in the presence of the amide in sample beam with the corresponding amide of same concentration in dichloromethane in the reference beam. The results obtained are shown in Table I and the spectra are shown in Fig. 1.

TABLE I

Amide	Wavelength in $m\mu$ of		
	Iodine absorption in dichloromethane	Iodine-amide complex absorption	$\Delta\lambda$ ( $m\mu$ )
N, N-Dimethylacetamide	510.2	357	153.2
N, N-Diphenylacetamide	510.2	373.1	137.1

The high polarity of the C=O group in amide is due to the interaction between  $\pi$ -orbitals of C=O group and  $P_z$  orbital of nitrogen atom. The  $\pi$ -P interaction is less in diphenyl amides because of the competitive effect of the phenyl ring for the lone pair of electrons in the nitrogen with the result that the donor strength of oxygen atom is less in diphenyl amides than in dimethyl amides. This explains the smaller shift of iodine absorption band towards lower wavelength in

complexes with diphenylacetamide than with dimethylacetamide. These results are in conformity with the earlier infra-red studies of the workers of this laboratory.

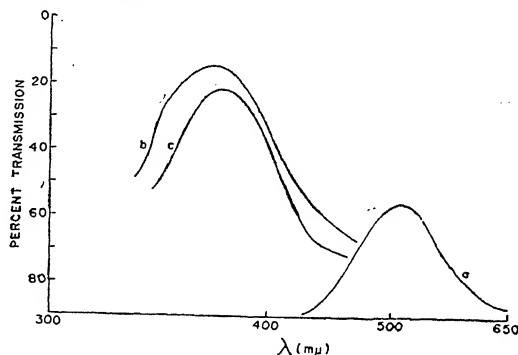


FIG. 1. Absorption Spectra of (a) iodine in dichloromethane, (b) iodine in dichloromethane with N, N-dimethylacetamide, (c) iodine in dichloromethane with N, N-diphenylacetamide.

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1. Puranik, P. G. and Venkata Ramiah, K., *J. Mol. Spec.*, 1959, 3, 487.
2. Miyazawa T., Shimanouchi, T. and Mizushima, S., *J.C.P.*, 1956, 24, 408.
3. Venkata Ramiah, K. and Venkata Chalapathi, V., *Curr. Sci.*, 1966, 35, 301.
4. —, India Chary, C. A. and Usha Bai, P., *Proc. Ind. Acad. Sci.*, 1967, 66, 279.
5. — and —, *Curr. Sci.*, 1968, 37, 130.
6. Kanekar, C. R., Ketrpal, C. L., Venkata Ramiah, K. and Indira Chary, C. A., *Proc. Ind. Acad. Sci.*, 1967, 66, 189.
7. Tsubomura, H. and Lang, R. P., *J. Am. Chem. Soc.*, 1961, 83, 2085.

### SPECTRUM OF PHENANTHRENE CATION IN THE BORIC ACID GLASS

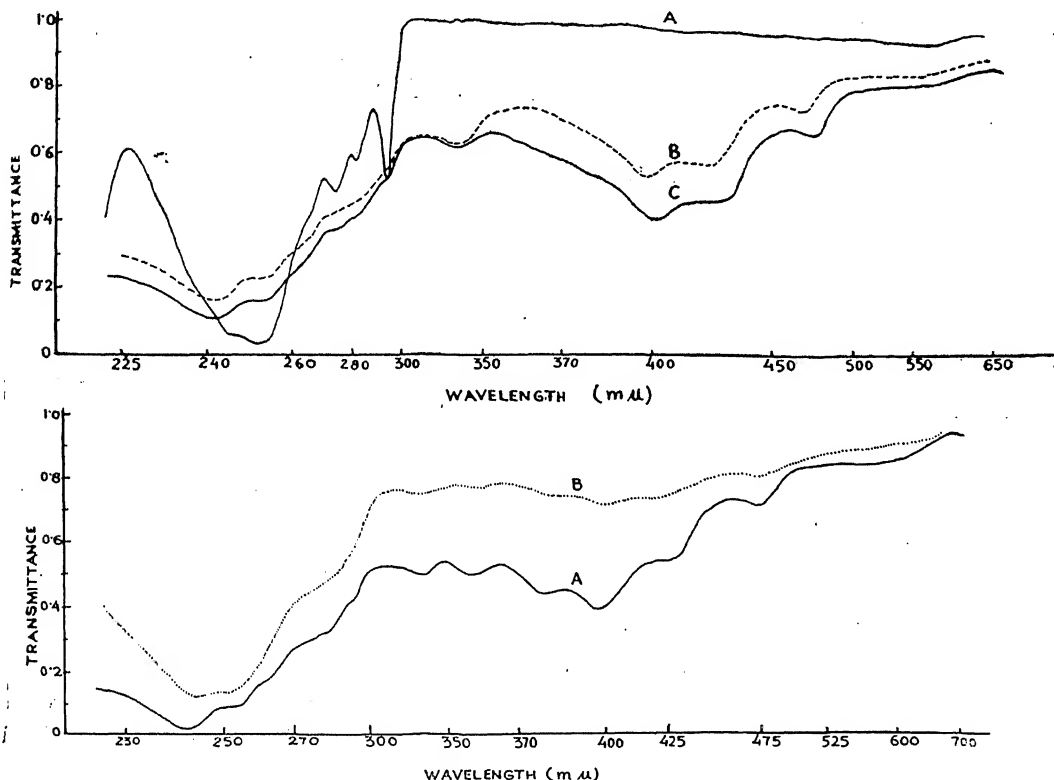
THE mono-negative molecular ion of phenanthrene has been prepared chemically by the reaction of alkali metals with neutral phenanthrene in suitable solvents and its spectrum has been investigated.<sup>1,4</sup> Though the mono-positive and mono-negative ions of alternant hydrocarbons are expected to give similar electronic spectra,<sup>5</sup> it will be interesting to study the spectrum of phenanthrene mono-positive ion, which does not appear to have been investigated so far. Attempts were made to prepare the cation of phenanthrene by

chemical oxidation in concentrated sulphuric acid, but phenanthrene proved almost insoluble in concentrated sulphuric acid and hence the method failed.<sup>6</sup> Shida and Hamill<sup>7</sup> have recently recorded the visible spectrum of phenanthrene cation, produced by  $\gamma$ -irradiolysis of phenanthrene solution in a polycrystalline matrix of  $\text{CCl}_4$  at 77° K. In the present note we are reporting the UV, and visible spectrum of phenanthrene cation formed by UV-irradiation of a rigid solution of phenanthrene in the boric acid at room temperature.<sup>8</sup>

The boric acid films doped with phenanthrene were prepared by the method reported earlier<sup>8</sup> and the spectrum was recorded in the

removed) or with X-rays from a Philips X-ray unit, and the spectra were recorded. Finally, the spectrum was obtained after irradiating the film at 110° C.

Figure 1 shows the spectrum of phenanthrene without irradiating and after irradiating the film with UV light. In Fig. 2, curve 'A' stands for the spectrum of phenanthrene after irradiating the film with X-rays for one hour. Effect on the spectrum, when phenanthrene doped boric acid film was irradiated at 110° C. for two hours is shown in Fig. 2, B. The positions of the principal band maxima, along with their approximate intensities for the spectrum of



FIGS. 1-2. Fig 1. Absorption curves of phenanthrene ( $\sim 0.1\%$  by weight) in the boric acid glass, (A): Before irradiation; (B) and (C): after irradiating with UV light for 3 and 30 minutes respectively. Fig. 2. Absorption curves of phenanthrene ( $\sim 0.1\%$  by weight) in the boric acid glass. (A): After irradiating with X-rays for 60 minutes; (B): after irradiating the film at 110° C., with UV light for two hours.

2200-7500 Å region with a Perkin Elmer double beam spectrophotometer. The film was then irradiated at room temperature with the UV light from a 80-watt high pressure mercury lamp (the glass envelope of the lamp was

phenanthrene cation, are given in Table I, and are compared with the spectrum of phenanthrene anion.<sup>2,3</sup> Obviously, the spectrum of phenanthrene cation is very similar to the spectrum of phenanthrene anion.

TABLE I  
Principal band maxima (in  $\text{kK}^*$ ) of  
phenanthrene ions

Mono-negative ion			Mono-positive ion
Reference 2	Reference 3	Reference 4	Present work
15.3	15.7	..	14.2 st†
22.5	22.4	22.4	21.2 vs
..	..	22.8	..
..	..	23.2	23.6 vs
24.1	24.1	24.0	25.2 vs
25.3	26.4	..	29.4 ms
..	..	..	30.1 m
..	..	..	30.6 w
..	..	..	31.5 d
..	..	..	34.1 d
..	..	..	35.5 d
..	..	..	36.6 d
..	..	..	39.5 s
..	..	..	41.1 vs

\*1  $\text{kK} = 1000 \text{ cm}^{-1}$ .

†s—strong, vs—very strong, ms—medium strong,  
d—diffuse.

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Department of Physics, Z. H. ZAIDI.  
Aligarh Muslim University, B. N. KHANNA.  
Aligarh (India), August 7, 1968.

1. Paul, D. E., Lipkin, D. and Weissman, S. I., *J. Am. Chem. Soc.*, 1953, **75**, 116.
2. Bak, P., Hoijtink, G. J. and Schreurs, J. W. H., *Rec. Trav. Chim.*, 1957, **76**, 813.
3. Boer, E. de and Weissman, S. I., *Ibid.*, 1957, **76**, 824.
4. Christodouleas, N. and Hamill, W. H., *J. Am. Chem. Soc.*, 1964, **86**, 5413.
5. Hoijtink, G. J., Velthorst, N. H. and Zandstra, P. J., *Mol. Phys.*, 1960, **3**, 533.
6. Aalbersberg, W. Ij and Hoijtink, G. J., *J. Chem. Soc.*, 1959, p. 3049.
7. Shida, T. and Hamill, W. H., *J. Chem. Phys.*, 1966, **44**, 2375.
8. Hussain, Z. and Khanna, B. N., *Curr. Sci.*, Accepted for publication.

#### A NOTE ON THE PROANTHOCYANIDINS OF WHITE GRAPES

The fruits of white grapes were one of the earliest sources of leucoanthocyanins.<sup>1</sup> Though considerable work has been done on other plant sources, white grapes have not been fully studied. As part of our work on proanthocyanidins (leucoanthocyanidins) of deciduous fruits, this early source is being reinvestigated. A brief mention of this work

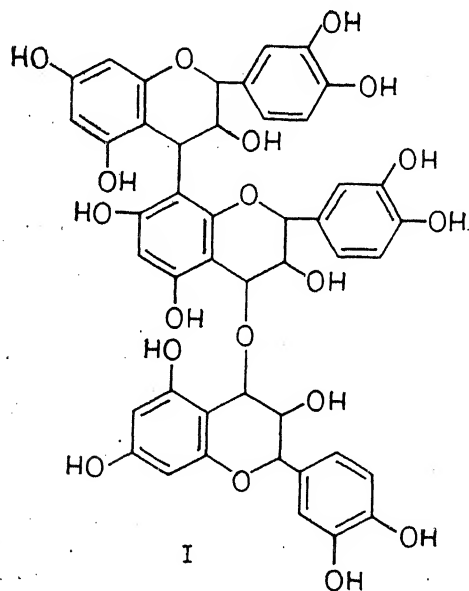
was made in the course of the Ghosh Memorial Lecture of the Indian Chemical Society.<sup>2</sup> There is considerable variation between different varieties of sweet grapes. More recently there has been a report by Joslyn and Dittmar<sup>3</sup> about the presence of proanthocyanidins in the skins and seeds of Point Blanc grapes. We are therefore presenting this note on one of the varieties which contains proanthocyanidins.

Colourless grapes *Pandhri sahebi* of Bombay were separated into peels, pulp, juice and seeds and each part extracted successively in the cold with light petroleum (60–80°), ether, ethyl acetate, acetone and methanol; the pulp and juice contained negligible amount of proanthocyanidins.

**Seeds.**—Light petroleum and ether extracts of the powdered seeds yielded a negligible amount of an oily residue. Ethyl acetate extract gave a small amount of a solid identified to be a derivative of leucocyanidin by its conversion into the flavylum salt and co-chromatography with an authentic sample of cyanidin. The major content of proanthocyanidin was extracted by acetone and methanol extracted the same component; the latter being better for the purpose was employed. The methanol extract after concentration under reduced pressure afforded a brownish sticky mass which turned into a clean solid when macerated with ethyl acetate (1.3 g. from 200 g. of seeds). It gave a green colour with alcoholic  $\text{FeCl}_3$  and with hot ethanolic  $\text{HCl}$  a deep pink-red colour developed and this gave a good yield of cyanidin chloride identical with an authentic sample (chromatography using Forestal solvent and spectral properties). No catechin or *epi*-catechin could be identified as a product of acid hydrolysis. The proanthocyanidin was most conveniently studied as its methyl ether. The proanthocyanidin (500 mg.) was methylated with  $\text{Me}_2\text{SO}_4$  (2 ml.) and  $\text{K}_2\text{CO}_3$  (102 g.) in acetone-MeOH (1:1) by refluxing for 48 hr. The product was a pale white solid. It was purified by passing through a column of silica gel and eluting with EtOAc. It did not give  $\text{FeCl}_3$  reaction. Its homogeneity was checked on T.L.C., (methanol, benzene, 3 : 7 and light petroleum, benzene, ethyl acetate, 5 : 1 : 8); m.p. 141–144°;  $[\alpha]_D^{29} = 29^\circ$  [Found: C, 64.4; H 6.2; OMe 32.0; m.w. (Rast) 1100.  $\text{C}_{57}\text{H}_{62}\text{O}_{19}$  required C, 65.1; H, 5.7; 12  $\text{OCH}_3$ , 35.4%; m.w. 1050]. It did not consume any periodate. The methyl ether acetate (acetic anhydride-pyridine, 24 hr.)

had m.p. 165–69°. Proanthocyanidin (20 mg.) was treated with acetic anhydride (1 ml.) and pyridine (0.5 ml.) for 24 hr. at room temperature and the product purified by passing through a column of silica gel; m.p. 154–57°,  $[\alpha]_D^{25} - 37^\circ$  [Found: C, 59.7; H, 4.6.  $C_{75}H_{68}O_{34}$  requires C, 59.5; H, 4.5%].

The absence of a glycolic system in the proanthocyanidin molecule was indicated by the failure of its methyl ether to react with sodium metaperiodate. Based on these observations and the analytical values the proanthocyanidin is considered to be a trimer of leucocyanidin having –C–C– and –C–O–C– linkages and having structure (I) as most probable.



**Peels.**—Light petroleum and ether extracts of 800 g. of peels gave small amounts of wax and a triterpene (200 mg.) respectively. The ethyl acetate extract contained very small amount of a proanthocyanidin, undergoing conversion into cyanidin chloride with acid. However the major quantity of the proanthocyanidin (300 mg.) came in acetone and better in methanol; with hot alcoholic HCl it gave only cyanidin chloride and no catechin.

The proanthocyanin (60 mg.) was methylated by boiling with  $Me_2SO_4$  (0.5 ml.),  $K_2CO_3$  (1 g.) and acetone (30 ml.) for 48 hr. The product on purification was checked on T.L.C. to be homogeneous in solvents given already. It had m.p. 162–65°;  $[\alpha]_D^{30} - 32^\circ$  [Found: C, 56.9; H, 6.1; m.w. about 450 (Micro Rast).  $C_{24}H_{30}O_{12}$  requires C, 56.5; H, 6.1; m.w. 510].

It consumed 3 moles of periodate. The above data indicated that the peels contained a monoglucoside for leucocyanidin.

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Department of Chemistry,  
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Delhi-7, August 20, 1968.

V. K. BHATIA,  
R. MADHAV,  
T. R. SESHADRI.

1. Brown, W. L., *J. Am. Chem. Soc.*, 1940, **62**, 2808.
2. Seshadri, T. R., *J. Ind. Chem. Soc.*, 1967, **44**, 628.
3. Joslyn, M. A. and Dittmar, H. F., *Chem. Abstr.*, 1968, p. 97657.

### ACID-SOLUBLE POLYSACCHARIDE OF COFFEE SEEDS

POLYSACCHARIDES from cold and hot water extracts of raw coffee seeds were obtained by Courtois and co-workers<sup>1</sup> and they were shown to be arabinogalactans containing small amounts of galacturonic acid. Wolf from *et al.* obtained water-soluble arabinogalactans from raw,<sup>2,3</sup> roasted<sup>2</sup> and instant coffee<sup>4</sup> which differ only in the degree of polymerization. They also obtained by ammonium oxalate extraction of the seed residue after water extraction, a polysaccharide containing rhamnose and mannose in addition to galactose and arabinose.<sup>2</sup> The acid extract of coffee seeds gives a polysaccharide which we have investigated.

Powdered samples of raw seeds of *Coffea arabica* and *Coffea robusta* were extracted with 80% ethanol to remove oligosaccharides and then with benzene : alcohol (2 : 1) to remove fats. The powder was then extracted with 5 volumes of 2 N hydrochloric acid at room temperature for 6 hours. The polysaccharide was precipitated by pouring the extract into 3 volumes of 95% ethanol. The precipitate obtained was redissolved in acid and reprecipitated two more times. A light brown material was obtained and the yields were 0.9% from *C. arabica* and 1.5% from *C. robusta*.

30 mg. of the thrice-precipitated polysaccharide was treated with 0.2 ml. of 72% sulphuric acid for 1 hour at 30° C. and then diluted with water to 4% sulphuric acid and heated for 6 hours on a boiling water-bath. The sugars in the hydrolysate were identified by paper chromatography in the solvent systems *n*-butanol : acetic acid : water, 4 : 1 : 1, and 4 : 1 : 5, v/v and *n*-propanol : benzyl alcohol : formic acid : water, 50 : 72 : 20 : 20, v/v, the last solvent system being very effective for separating arabinose and mannose. The sugars

were also quantitatively estimated by the phenol-sulphuric acid method<sup>5</sup> after chromatographic separation.

The polysaccharides from both species of coffee seeds contained rhamnose, arabinose, mannose and galactose. The amounts of the sugars obtained from 100 mg. of the polysaccharide are given in Table I.

TABLE I  
Monosaccharides obtained by hydrolysis of  
100 mg. of the polysaccharide

Species of Coffee	Amount of sugar in mg.			
	Rhamnose	Arabinose	Mannose	Galactose
<i>C. arabica</i>	10.33	30.69	29.5	19.18
<i>C. robusta</i>	9.90	30.34	26.32	18.80

The ratio of the sugars present in the polysaccharides from both species of coffee seeds is very nearly the same and is approximately 1:3:2.7:1.9. Therefore, there does not appear to be any difference in the nature of the polysaccharide from the two species of coffee seeds, though there is a difference in yield.

The order of liberation of sugars during the partial hydrolysis of the polysaccharides was determined by heating 20 mg. of the material with 2 ml. of 0.2N sulphuric acid on a boiling water-bath. Aliquots were withdrawn at intervals up to 4 hours and examined by paper chromatography. At 15 minutes there was a considerable amount of arabinose and traces of galactose in the hydrolysate. Small amounts of mannose and traces of rhamnose could be detected at 45 minutes. There was a progressive increase in the concentrations of all the sugars with time. Arabinose reached a maximum in 1-1½ hours. Oligosaccharides appeared in the ½ hour hydrolysate and their number and concentration increased with time. These observations are in conformity with those of Wolfrom<sup>2</sup> and Aspinall<sup>6</sup> with coffee and soyabean polysaccharides respectively, showing thereby that arabinose is in the labile furanoid form.

The polysaccharide preparations contained 3.3% (*C. arabica*) and 2.6% (*C. robusta*) nitrogen. The acid hydrolysates of the polysaccharides, however, gave a few very weak ninhydrin positive spots on chromatography indicating that the nitrogen of the preparation was mostly non-protein nitrogen.

The acid-soluble polysaccharide of coffee seeds therefore appears to differ from the

water-soluble polysaccharide in containing rhamnose and mannose, and in sugar composition resembles the ammonium oxalate extracted polysaccharide.

Dept. of Chemistry, M. SHADAKSHARASWAMY.  
Central College, GEETA RAMACHANDRA.  
Bangalore University,  
Bangalore-1, July 24, 1968.

1. Glomaud, J. Cl., Percheron, P. and Courtois, J. E., *Colloq. Intern. Chim. Cafes Vert.*, 2nd, Paris, 1965, p. 39.
2. Wolfrom, M. L., Plunkett, R. A. and Laver, M. L., *J. Agr. Food Chem.*, 1961, 8, 58.
3. — and Patin, D. L., *J. Org. Chem.*, 1965, 30, 4060.
4. — and Anderson, L. E., *J. Agr. Food Chem.*, 1967, 15, 685.
5. Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A. and Smith, F., *Analyt. Chem.*, 1956, 28, 350.
6. Aspinall, G. O., Begbie, R., Halmilton, A. and Whyte, J. N. C., *J. Chem. Soc.*, 1967, p. 1065.

#### AMPEROMETRIC DETERMINATION OF Se (IV) AND Te (IV) IN HYDROCHLORIC ACID AS XANTHATES

VERY few electroanalytical titration methods are known for the estimation of selenium and tellurium. In the present work attempts were made to titrate Se<sup>+4</sup> and Te<sup>+4</sup> individually with potassium ethyl xanthate by amperometry. The titration for both the elements were carried out in hydrochloric acid. Both selenium and tellurium are reducible in the above medium at the dropping mercury electrode. Selenium gives two waves, the first at -0.1 V and the second at -0.25 V vs. S.C.E. Only a single wave is produced by tellurium at -0.4 V. When selenium and tellurium solutions are titrated with xanthate amperometrically, the current decreases initially due to the precipitation of xanthates. After the elements are completely precipitated, the current becomes steady as the excess xanthate added decomposes in the presence of acid. This has been taken as the basis for the estimation of selenium and tellurium amperometrically.

#### EXPERIMENTAL

**Reagents and Apparatus.**—Sodium selenite solution was prepared from B.D.H. sample and its strength was determined iodometrically.<sup>1</sup>

Sodium tellurite of 0.1 M concentration was prepared and its tellurium content was verified by the classical procedure.<sup>2</sup>

Stock solution of 0.05 M xanthate was prepared and its strength was checked gravimetrically.<sup>3</sup>

Hydrochloric acid used was of AnalaR quality and the titrations were carried out with a Fisher Electropode.

**Procedure.**—A number of preliminary experiments were carried out to find the suitable acid concentration. It has been observed that reproducible results were obtained in the case of selenium with hydrochloric acid strength ranging between 1-6 N and with tellurium from 4-5 N.

**Titration of Selenium.**—In the final procedure adopted, an aliquot of sodium selenite was taken in the titration cell and a requisite amount of hydrochloric acid was added to maintain its overall normality at 1. A potential of  $-0.4$  vs. S.C.E. was applied. The initial galvanometer reading was noted and xanthate solution was added in aliquots. After each addition, the selenium xanthate precipitate was allowed to settle down and current reading was noted. The process was repeated till the whole of selenium was precipitated with a sufficient excess of xanthate. When the current readings were plotted against the volume of xanthate an L-shaped graph was obtained and the intersection of the two lines gave the end-point.

**Titration of Tellurium.**—The titration was carried out as in the case of selenium at an applied potential of  $-0.5$  V vs. S.C.E., maintaining the overall normality of hydrochloric acid at 4. The end-point was obtained graphically.

A number of experiments have been carried out with different concentrations of Se(IV) and Te (IV) and the results are returned in Table I. From the observed results it has been seen that selenium xanthate and tellurium xanthate possess the formulæ  $(C_2H_5OCS.S)_4$  Se and  $(C_2H_5OCS.S)_4$  Te respectively.

TABLE I

Amperometric titration of Se(IV) and Te (IV) in hydrochloric acid as xanthates

S. No.	Selenium mg.		Difference mg.	Tellurium mg.		Difference mg.
	Taken	Found		Taken	Found	
1	0.987	0.987	..	1.595	1.588	-0.007
2	1.382	1.362	-0.020	1.914	1.945	+0.031
3	1.580	1.590	+0.010	2.552	2.552	..
4	1.975	1.985	+0.010	3.190	3.190	..
5	2.370	2.374	+0.004	3.828	3.796	-0.032
6	2.765	2.759	-0.006	4.466	4.496	+0.030
7	3.160	3.171	+0.011	5.742	5.755	+0.013

Dept. of Chemistry,  
Banaras Hindu Univ.,  
Varanasi, May 23, 1968.

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V. S. SANKARA RAO.

1. Vogel, A. I. *A Text-book of Quantitative Inorganic Analysis*, ELBS and Longmans Green and Co., 3rd Edition, 1962, p. 303.
2. —, *Ibid.*, p. 324.
3. Reyckler, *Bull. Soc. Chim. Belg.*, 1928, 37, 165.

### DISTRIBUTION OF ISOMORPHOUS SALTS BETWEEN AQUEOUS AND SOLID PHASES IN FRACTIONAL CRYSTALLIZATION

FRACTIONAL crystallization as ordinarily carried out results in systems that are in a state of non-equilibrium. Nevertheless such systems can be studied with the aid of equations developed for systems in equilibrium.

The present communication reports an attempt made to test the applicability of Abu Elamayem's equation<sup>1</sup> for the two systems (a) Ni/Mg ammonium sulphate-water and (b) Pb/Ba nitrate-water.

**Procedure.**—The experimental procedure consists of heating a known amount of water together with known amounts of the salts in a closed vessel till the salts dissolve completely, and then keeping the vessel in a thermostat maintained at  $30 \pm 0.02^\circ \text{C.}$ , for 6 hours. During this period the contents of the flask are shaken frequently by swirling the flask with the stopper on, without removing it from the thermostat. At the end of 6 hours, the crystals are separated from the mother liquor and are analyzed for each of the components.

In system (a), the moist crystals were dissolved in water and Ni was separated and estimated from the entire solution by electrolytic deposition<sup>2</sup> on a previously weighed cylindrical Pt-Gauze electrode (Surface area  $125.0 \text{ cm.}^2$ ). The solution free from nickel was then made up to a known volume and magnesium was determined, in an aliquot, by the oxinate method.<sup>3</sup>

In the case of lead/barium/nitrate system, the moist crystals were dissolved in water and made up to a known volume. From a suitable aliquot, lead was determined by separation as  $\text{PbO}_2$  by anodic deposition<sup>4</sup> from a nitric acid solution. The lead-free solution was evaporated nearly to dryness. The residue was dissolved in water and barium was determined as its carbonate.<sup>5</sup> The conventional method of estimating barium as its sulphate was not adopted on account of the errors that would arise from adsorption of nitrate on the precipitate.

The analyses so made yield the amounts of the two salts in the solid phase which also

TABLE I

(a) $\frac{\text{Ni}}{\text{Mg}}$ ammonium sulphate-water. $[K=4.2, m=0.8, a=\frac{1}{3}]^*$							
$w$		0.090	0.100	0.206	0.298	0.424	
$y$	Theoretical	0.699	0.681	0.664	0.634	0.584	
	Experimental	0.704	0.686	0.663	0.629	0.568	
(b) $\frac{\text{Pb}}{\text{Ba}}$ nitrate-water. $[K=3.6, m=0.8, a=\frac{1}{3}]^*$							
$w$		0.095	0.166	0.226	0.313	0.372	0.453
$y$	Theoretical	0.650	0.632	0.616	0.590	0.570	0.543
	Experimental	0.651	0.640	0.610	0.580	0.552	0.529

\*  $K$  and  $m$  have been chosen to fit the experimental results with the theoretical equation given by Abu Elamayem.

contains a small amount of the mother liquor. A correction was applied for the amount of salts present in the adhering mother liquor. This is easily done by calculating the weight of water present in the moist crystals and the amount of salts held by this water. From the weight of the mother liquor and the amount of the salts present in it, it is possible to calculate the weight of water in the moist crystals and the weight of the salts held by the water. Although the analysis of the aqueous phase is not required, this analysis was carried out in a few experiments, to obtain a check on the results of analysis of the solid phase.

Based on the ideas suggested by Sugden, Abu Elamayem has proposed the equation for a non-equilibrium system:

$$-\frac{dy}{dw} = \frac{1}{w} \left[ \frac{1}{1 + \frac{M_B}{M_A} \left\{ \frac{1}{K(a-wy)} - 1 \right\} \frac{M_A}{M_B} m} - y \right] \quad (1)$$

where

$w$  = weight fraction of the original mixture that has separated as crystals;

$y$  = weight fraction of the less soluble salt in the crystals;

$a$  = weight fraction of the less soluble salt in the initial mixture.

$M_A$  and  $M_B$  are the molecular weights of the two salts;

$K$  and  $m$  are empirical constants.

The importance of equation (1) lies in the fact that it is possible to calculate theoretically the amount of the less soluble salt (expressed as weight fraction  $y$ ) that will be present in a given weight of crystals (expressed as weight fraction  $w$ ) that separate during crystallization. This calculation involves the numerical

integration of equation (1) by modified Euler's method" and the values obtained for the systems (a) and (b) are shown in Table I.

These theoretical results are in good agreement with the experimental values obtained. The value of  $y$  increases with decrease in  $w$  and hence it is possible to make separation of the less soluble salt more effective by allowing a small weight fraction of the crystals to separate out of the ternary system.

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1. Abu Elamayem, M. A., *J. Inorg. Nucl. Chem.*, 1964, **26**, 2159.
2. *Scott's Standard Methods of Chemical Analysis*, 5th Edn., D. Van Nostrand Company, Inc., New York, 1961, **1**, 620.
3. *Ibid.*, p. 535.
4. *Ibid.*, p. 507.
5. *Ibid.*, p. 126.
6. Shepley L. Ross, *Differential Equations*, Blaisdel Publishing Company, a division of Ginn and Company, London, 1964, p. 282.

### THE MIGMATITE ZONE OF LAHAUL AND SPITI VALLEY AND THE CENTRAL GNEISSES

DURING the course of a recent traverse in the Lahaul and Spiti Valley via Manali and Rohtang Pass, the area lying between latitudes  $32^\circ 15'$  and  $32^\circ 35'$  and longitudes  $76^\circ 52'$  and  $77^\circ 35'$  which is included in the 'Central Himalayan zone' or Great Himalayas was examined.

The traverses revealed many interesting and hitherto undescribed geological features like the development of migmatites on a regional



scale in long, uninterrupted and continuous stretches, extensive development of agmatites and agmatitic fronts and the transformation of the metasedimentaries into paragneisses.

The discovery of these rocks and features from the central crystalline axial region is important as these very clearly and conclusively give the evidences of the involvement of the pre-Cambrian crystalline basement rocks in the Himalayas upon which, in the *trans-Himalayan* zone, fossiliferous sediments ranging in age from Cambrian to Cretaceous have been deposited.

It has been found that the so-called 'central gneisses' are in fact crystalline complexes made up of ancient schists, quartzites with occasional basic sills and dikes now metamorphosed into amphibolites. The metasedimentaries have been transformed by the processes of migmatization and granitization into paragneisses. Even the meta-basics have not been spared in the process. Every stage of migmatization and transformation of these rocks into paragneisses is traceable on a regional scale. The migmatites exposed for a length of about 30 miles on both sides of the Chandra river from Chota Dara upto Gondla on Kaza Kyalong motor road in Lahaul and Spiti Valley bear evidence to the above.

Structurally the crystalline rocks of the area on the Himalayan central (axial) and *trans-Himalayan* zone form a doubly plunging major anticline trending NW-SE, along the faulted axis of which Chandra river is flowing. This anticline is superimposed on the earlier major structures like anticlines and synclines having a N-S and NNE-SSW axial trends. One such major anticline with a NNE-SSW axial trend can be seen in the vicinity of village Marhi on way to Rohtang pass from Manali. These earlier folds and other structures can be traced across the Chandra river towards the north in spite of the major fault referred to above.

On the northern, north-western and north-eastern flanks of the NW-SE trending major fold, the fossiliferous Palaeozoic and Mesozoic Tethyan sediments have been deposited in the *trans-Himalayan* zone thereby conclusively demonstrating the pre-Cambrian age of the crystalline zone.

On the *cis*-axial side, these crystalline rocks form the root zones of nappes and thrusts which have travelled far to the south overriding the almost unfossiliferous Palaeozoic and Mesozoic and in some cases fossiliferous Tertiary Himalayan sediments too.

Since these crystalline rocks form the basement of definite early Palaeozoic Cambrian sediments, it is concluded that the crystalline schists and paragneisses of the *cis*-, axial and *trans-Himalayan* zone are also pre-Cambrian. The crystalline rocks appear to form the components of a rock which may be designated as a 'fundamental schist and gneiss complex' like fundamental gneissic complex of the Indian shield. This 'fundamental complex' has also been later intruded by younger tourmaline granites and pegmatites.

Detailed investigation on structural features and the various types of migmatites and migmatite derivatives, etc., are being carried out by Sri. Kedar Narain.

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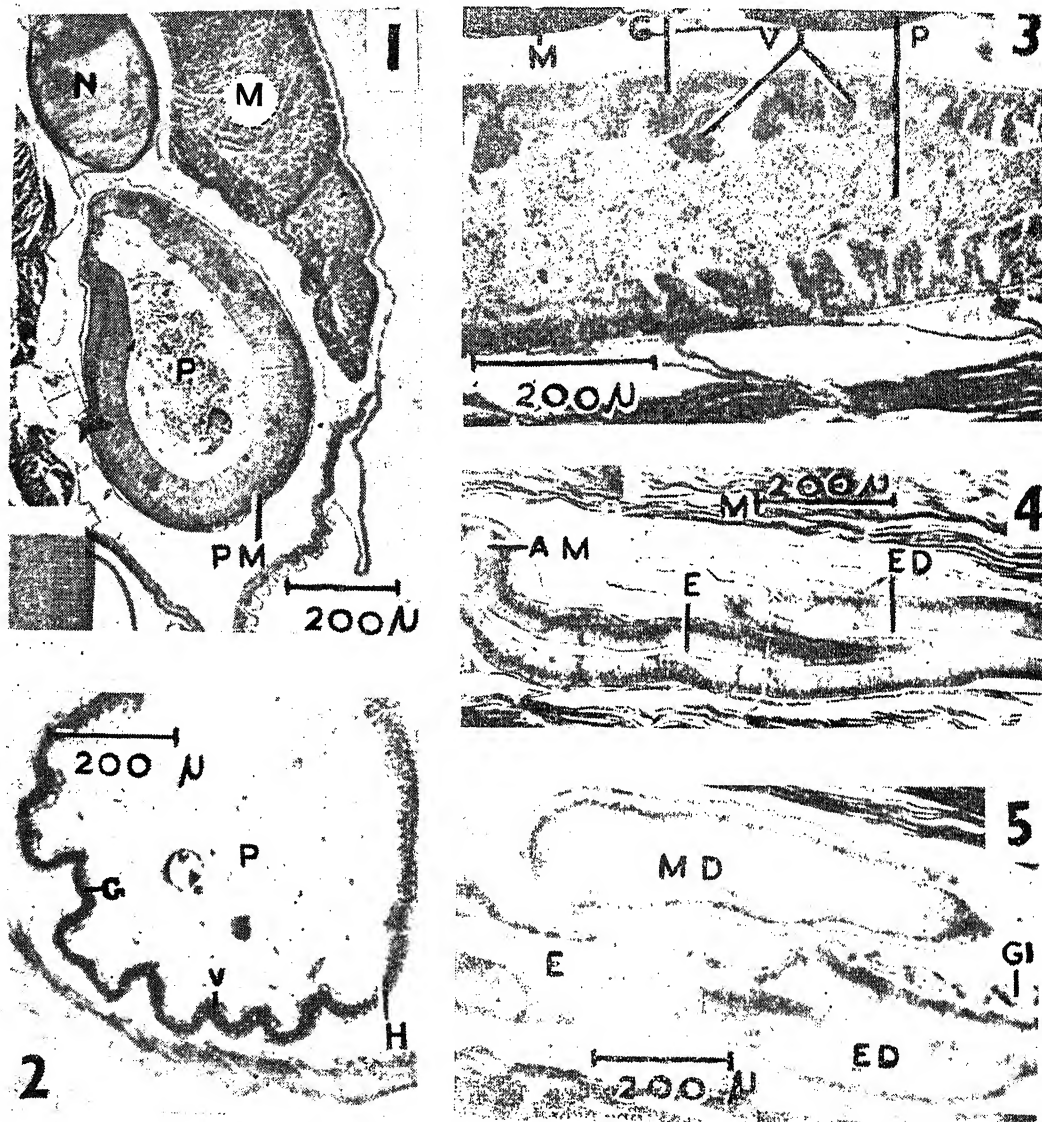
#### OBSERVATIONS ON THE GUT WALL OF AMPHIOXUS (*BRANCHIOSTOMA* *LANCEOLATUM*)

EARLIER workers<sup>1,2</sup> have observed that the post-pharyngeal gut in amphioxus is divisible into oesophagus, mid-gut, mid-gut diverticulum, ilio-colon ring and hind-gut. The lumen of the gut is tubular in shape and its wall smooth and ciliated (Fig. 1). Since there is no visceral musculature overlying the gut, peristalsis does not play a part in the transportation of food. A detailed examination of 10 specimens of *Branchiostoma lanceolatum* has shown that the gut wall does not always conform to the same pattern in all the specimens. The methods employed for the present anatomical study have already been described.<sup>3</sup>

Although the oesophagus (Figs. 4 and 5, E) has a simple tube-like structure additional diverticulæ (ED) were observed, one on the right and the other on the left. Their role in the physiology of nutrition is not known. In another two specimens, however, the gut wall (G) showed villi-like structures (Figs. 2 and 3, V). In such cases the gut epithelium itself is thrown into villi-like structures which are shaped irregularly. A similar feature was observed in the hind-gut (H) region (Fig. 2). In this specimen the ventral epithelium is not

even and shows loop-like folds which are similar to the one observed earlier. The dorsal epithelium of the same region is smooth and devoid of such formations. A close observation of these specimens shows a correlation between the amount of particulate matter (P)

matter greater number of villi are formed (Figs. 2 and 3). It is reasonable to suggest that the formation of the gut epithelial villi may increase the absorptive surface area. It is of interest to recall in this context an earlier suggestion<sup>2</sup> that the transportation of food cord



FIGS. 1-5. Fig. 1. Transverse section through the posterior mid-gut region. Fig. 2. Transverse section through the hind-gut region. Fig. 3. Sagittal section showing the villi formation. Figs. 4-5. Oesophagus with diverticulæ. AM, Anterior mid-gut; GI, Gill slits; M, Myotome; MD, Mid-gut diverticulum; N, Notochord; PM, Posterior mid-gut. Rest of the letterings are referred in the text.

in the gut and the villi formed. For instance, when the gut is comparatively empty the gut wall is smooth (Fig. 1). Whereas when the gut lumen is filled with particulate food

and absorption of digested food may be facilitated by the inpushing of specialised cells of one region into the other on the dorso-lateral region of the gut. Further experimental study

is required to elucidate the formation of villi and their significance.

I am thankful to Prof. G. Krishnan for his interest in the work.

Department of Zoology, JAYAPPAUL AZARIAH.  
University of Madras,  
Madras-5, July 1, 1968.

1. Barrington, E. J. W., *Phil. Trans. Roy. Soc. Lond. B*, 1937, 228, 269.
2. Azariah, J., *J. Mar. biol. Ass. India*, 1967 (In press).
3. — *Ibid.*, 1966, 8, 159.

### CLAY MINERALOGY OF THE MUD BANKS OF COCHIN

THE deposition of mud on the beaches of Kerala is a recurring feature. This phenomenon is particularly common between Calicut and Quilon and is most frequent during the monsoon season. The formation of offshore bars of mud as well as the deposition of mud on the beaches have been collectively termed "mud banks". Bristow<sup>1</sup> gives a comprehensive account of mud banks, particularly their occurrence at various places, their so-called movement, the calming effect they have on the waves and speculations regarding their origin. A subsequent report by the Special Committee on the Movement of Mud Banks (DuCane<sup>2</sup>) is more instructive in so far as some work on the physical and chemical aspects of the mud is concerned. Results of the studies on some other aspects of the muds have been given by Nair *et al.*<sup>3</sup>

This paper is a report of the mineralogy of the sediment constituting the mud-banks formed off Cochin (Fig. 1). The results obtained particularly the clay mineral composition are used as a means of understanding the nature and source of origin of the muds. An investigation along the same lines is that of Favajee (quoted by Carroll in Milner).<sup>4</sup>

The fine fraction of the mud samples were analysed X-ray diffractometrically for their clay mineralogy. The results are given in Table I. The minerals detected are kaolinite, montmorillonite, illite, chlorite with some calcite and quartz in all samples. The presence of gypsum and hydrous phosphate was also noted.

**Kaolinite.**—Dominating the clay minerals in the muds are the kaolinites being 60–65% of the total. As the doublet at 4.13 Å and 4.18 Å is not resolved it is inferred that these kaolinites are poorly crystallised. In view of the

fact that lateritic soils are principally kaolinitic, it is not surprising that kaolinite is the dominating clay mineral in these muds. Apart from the contributions from the weathering of primary source rocks like acid igneous rocks, it is also possible that a certain amount is derived directly from secondary sources such as kaolinite deposits occurring in parts of the State, viz., the Miocene Varkala deposits outcropping near the coast and its offshore extensions.

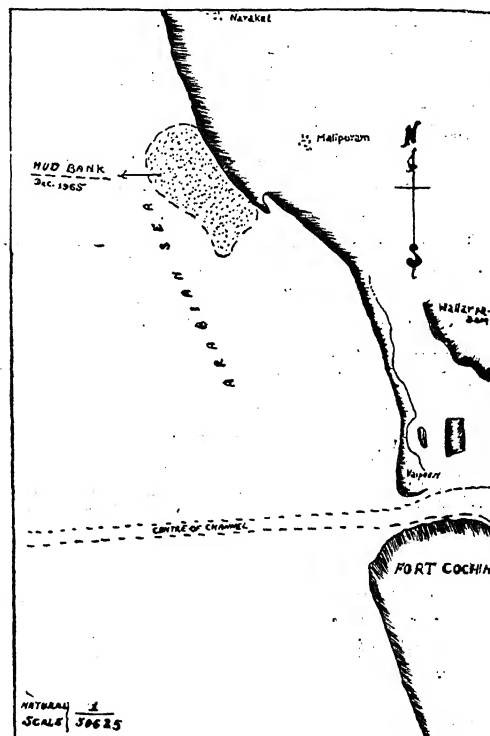


FIG. 1

TABLE I

Mineralogy of the mud banks

	M-2	M-4	M-8	M-17
Kaolinite	60–65%	60–65%	60%	55–60%
Montmorillonite	15–20%	15%	15–20%	15–20%
Illite	15%	15–20%	15–20%	20%
Chlorite	Trace	Trace	—	—
Quartz	2–5%	2–5%	2–5%	2–5%
Calcite	Trace	Trace	1–2%	1–2%
Gypsum	—	++	+	+
Hydrous phosphate	+	++	+	+

Note: Percentages are on Gypsum and Hydrous phosphate free basis.

**Montmorillonite.**—Next in order of abundance are the montmorillonites ranging between

15-20%. These again are poorly crystallised and trioctahedral. Furthermore most of the montmorillonites are of the saponite variety. Saponites are considered to result from complete substitution of aluminium by magnesium in the octahedral sheet (Grim).<sup>5</sup> The formation of montmorillonite is generally favoured where basic igneous rocks are subject to weathering in hot and moist climates, with the provision that the process of leaching, particularly the magnesium ion be none too rapid. These conditions are ideally met with in the interior of the State and it may therefore be reasoned that one of the possible ultimate sources of the saponites are the magnesium-rich pyroxene granulites found in the hinterland of Kerala (Krishnan).<sup>6</sup>

**Illite.**—Illite occurs in quantities comparable to montmorillonite (15-20%). The illite is dioctahedral and poorly crystallised. These are probably related to the weathered muscovites which was observed to be present in the coarse fraction of the sediments.

**Chlorite.**—Only trace quantities of this mineral were recorded in the muds. Quartz, calcite and gypsum were detected in small amounts in all the samples. Some of the samples showed a hydrous phosphate peak, which could be apatite. It is, however, not known whether this apatite is biogenic or inorganically precipitated.

From these observations, we conclude that the clay minerals of the mud banks show decided affinities to the parent rocks and are considered to result under conditions of tropical weathering of a variety of rocks. The essentially terrestrial nature of the clays is confirmed by the predominance of kaolinite over the montmorillonites and illites, the latter two being more typical of sediments found in the marine environment.

This further leads to the conclusion that little or no contribution to the sediment is made from the open sea and that the sediments constituting the muds are largely contributed to the near-shore region by the present-day rivers, either directly to the inner shelf or indirectly by way of the lagoons. Redistribution of such sediments by the waves and currents would result in the formation of mud banks and mud flats.

The authors are grateful to Dr. N. K. Panikkar, Director, National Institute of Oceanography, for his interest and encouragement, to Dr. V. V. R. Varadachari for discussion and to Dr. Tj. Peters of the Institute

of Mineralogy and Petrology of the University of Berne for the X-ray diffraction analysis.

Physical Oceanography R. R. NAIR.  
Division of National P. S. N. MURTY.  
Institute of Oceanography,  
Ernakulam, June 10, 1968.

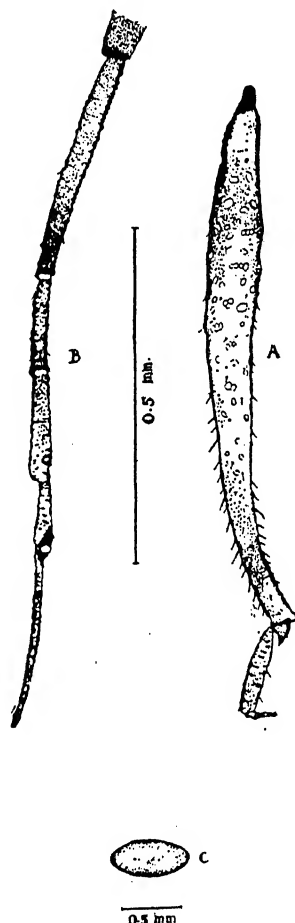
1. Bristow, R. C., *Cochin Harbour Development—History of Mud Banks*, Cochin Govt. Press, Ernakulam, 1938, 1 & 2.
2. DuCane, C. G., *Report of the Special Committee on the Movement of Mud Banks*, Cochin, 1938.
3. Nair, R. R., Murty, P. S. N. and Varadachari, V. V. R., "Abstracts of Papers," *INCOG/NIO Symposium on "Coastal and Nearshore Oceanography"*, Ernakulam, November 3-4, 1966.
4. Carroll, D., *Sedimentary Petrography*, George Allen and Unwin Ltd., London, 1962, 2.
5. Grim, R., *Clay Mineralogy*, McGraw-Hill and Company, 1953.
6. Krishnan, M. S., *Geology of India and Burma*, Higginbothams, Madras, 1964.

#### OVIPAROUS MORPHS OF *LIPAPHIS ERYSIMI* (KALTENBACH) IN INDIA\* (HOMOPTERA: APHIDIDAE)

*Lipaphis erysimi* (Kaltenbach), a cosmopolitan aphid infesting crucifers, is generally known to build up populations parthenogenetically in tropical countries. Sexual morphs of this aphid have been recorded and are well known from temperate zones in Europe and elsewhere (Hille Ris Lambers, 1949; Bodenheimer and Swirski, 1957). There is no published record of the occurrence of oviparae from India even from the temperate regions at higher altitudes in the north though Verma and Mathur (1966) recorded male morphs of *L. erysimi* in Jammu. The present author noticed the prevalence of apterous oviparae on *Brassica campestris* at 4,000-4,500 ft. in widely separated areas of Kalimpong and Mirik in Darjeeling District, West Bengal, during the first fortnight of March 1967 when the mean temperature was 17° C. However, no male morphs were encountered. The oviparae are morphologically differentiated from alate and apterous virginoparae by their swollen hind tibiae with pseudo-sensoria (Fig. A) and slight differences in the proportion of various antennal segments (Fig. B). Cottier (1953) described the oviparous morph from a single specimen collected on Shepherd's purse [*Capsella bursa-pastoris* (L.) Medik.] at Auckland (New Zealand), early in October 1945.

Dissection of oviparous females showed 7-11 eggs but none laid more than 8. The egg (Fig. C) was ovoid, shiny, greyish-green with

a tough chorion, measuring 0.63 mm. long and 0.31 mm. broad. The fertilised eggs turned black and apparently entered into a diapause.



FIGS. A-C. *Lipaphis erysimi* (Kltb.). Fig A. Hind tibia and tarsus of ovipara. Fig. B. Antenna of ovipara. Fig. C. Egg.

Production of oviparae in Kalimpong appears to be related to short photoperiods and low temperatures. Lees (1963) stated that in controlled experiments with *Megoura viciae* Buckton, 12-hr. short day applied led to the production of oviparae at temperatures below 23° C. The time of appearance of oviparae in Kalimpong is well within this limit. Large swarms on *B. campestris* originated from wild crucifers. The author often noticed small colonies of virginoparae during August-September on a small cruciferous plant, *Cardamine hirsuta*, which grows in shady, cool surroundings.

The author is grateful to Dr. V. P. Rao for his encouragement and also thankful to Miss

Louise M. Russel, U.S.D.A., Washington, D.C., for critically going through the manuscript.

Commonwealth Institute of Biological Control,  
Indian Station,  
Bangalore, July 4, 1968.

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1. Bodenheimer, F. S. and Swirski, E., *The Aphidoidea of the Middle East*, The Weizmann Science Press of Israel, Jerusalem, 1957, p. 378.
2. Cottier, W., "Aphids of New Zealand," *N.Z. Dept. Sci. and Ind. Res. Bull.*, 1953, 106, 382.
3. Hille Ris Lambers, D., "Contributions to a monograph of the Aphididae of Europe" *Temminckia*, 1949, Pt. IV, 8, 182.
4. Lees, A. D., *J. Insect Physiol.*, 1963, 9, 153.
5. Verma, K. D. and Mathur, A. C., *Indian J. Ent.*, 1966, 28 (2), 277.

# ON A SUPERNUMERARY FRAGMENT CHROMOSOME IN *EPHEDRA FOLIATA* BOISS.

IN the literature available on the cytology of gymnospermous plants no record of the occurrence of accessory chromosomes either in the form of supernumerary fragments or B-chromosomes is found, except in *Taxus canadensis* where 12 bivalents and a "small chromosome assumed to have arisen as a fragment" were reported.<sup>1</sup>

During the present study on the cytology of the pollen mother cells of *Ephedra foliata* Boiss., growing in the Bangalore University Botanical Garden, a single fragment chromosome in addition to the regular complement of seven bivalents (or occasionally six bivalents and two univalents) was observed at almost all stages of meiosis in a considerable percentage of the nuclei examined (Table I).

TABLE I  
Frequency of occurrence of the fragment chromosome during the first meiotic division

Stage	Total number of nuclei studied	Nuclei with fragment			
		Total	Paired		Unpaired
		Number Percentage	Number Percentage	Number Percentage	Number Percentage
Pachytene ..	18	3 ..	.. ..	3 ..	..
Diplotene ..	12	2 ..	.. ..	2 ..	..
Diakinesis ..	170	34 20.00	4 11.80	30 88.20	..
Metaphase I ..	183	40 21.85	6 15.00	34 85.00	..

At pachytene, the fragment could be studied only in three cells when lying free and away from other bivalents. As observed from aceto-carmines squashes a centromere could not be located and the fragment is mostly heterochromatic. Diplotene is a difficult stage for study; in a few nuclei the fragment was a darkly staining body and any pairing to a bivalent could not be made out with certainty.

About 20% of the nuclei studied at diakinesis revealed the presence of the fragment, it being absent not only from some anthers of a flower but even from some pollen mother cells of an anther. In 11.8% of the cases studied the fragment was found paired to one of the chromosomes of a bivalent.

The fragment was located in 21.8% of the nuclei analyzed at metaphase I; in 15% of these it was paired to a chromosome of a bivalent which always formed a single chiasma that remained unterminalized even at very advanced stages of metaphase I. On the basis of this and other observations herein, it is considered improbable that mere stickiness alone is responsible for the association of the fragment and the chromosome. It is also considered that the pairing between the fragment and the chromosome has probably been side by side followed by the formation of a chiasma which subsequently got terminalized resulting in the condition shown in Figs. 1 and 2. An end-to-end pairing is unlikely to bring

in such a situation. Figs. 1 and 2 conclusively show the paired condition of the fragment in pollen mother cells from anthers of different flowers at metaphase I.

The behaviour of the fragment was found to be highly variable obviously due to a very weak or no centromeric activity. Only in those nuclei where it had a pairing association the fragment was found on the equatorial plate and segregated to a pole along with the chromosome to which it was paired. In other cells it was usually near one of the poles or sometimes near the centre of the cell but indifferent to the equatorial plate. It remained undivided in most of the cases and was included in one of the daughter nuclei at the end of the first meiotic division. In very few cases it was observed to have divided and the products of the division were included in the same daughter nucleus. Neither the fragment singly nor the products of its occasional division were observed on the equatorial plates at metaphase II, while at anaphase II they were found near one of the poles or occasionally between two daughter nuclei of different spindles of the second division and subsequently got included in one of the spores of the tetrad to be eliminated as micronuclei. About 6% of the microspores showed a single micronucleus.

The fragment has no discernible genetic effects. The frequency of incidence and the variable behaviour of the fragment chromosome resulting mostly in its elimination are suggestive of a recent origin.

The author is grateful to Prof. M. Nagaraj, Bangalore University, for facilities and encouragement and to Prof. J. Venkateswarlu, Andhra University, for suggestions.

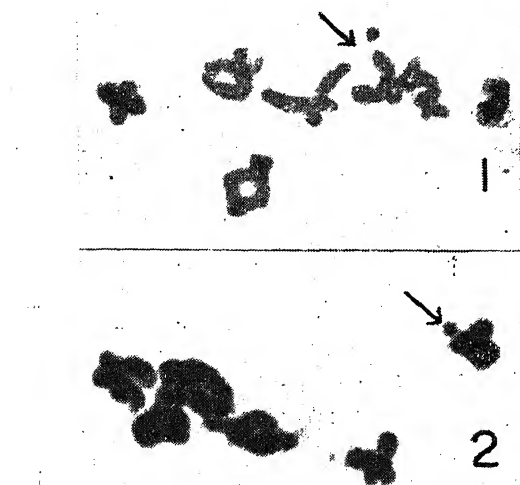
Dept. of Botany, C. KAMESWARA RAO.  
Bangalore University,  
Bangalore-1, June 28, 1968.

1. Dark, S. O. S., *Ann. Bot.*, 1932, 46, 965.

## GRASSY SHOOT DISEASE OF 'SUGARCANE

### II. Hot-air Therapy

THE grassy shoot disease (GSD) of sugarcane reported for the first time in 1955 from Maharashtra<sup>1-8</sup> has now spread to all the major sugarcane-growing tracts of the country<sup>6</sup> and it is even feared that some of the varieties now under cultivation may have to be given up because of susceptibility to GSD. GSD



FIGS. 1-2. Metaphase I showing fragment in paired condition,  $\times 1,250$ . Fig. 1. The thread-like connection between the fragment and the chromosome of the bivalent is shown by an arrow. Fig. 2. Arrow marks the fragment,

affected clumps yield few millable canes and are characterised by retarded growth, profuse and premature tillering. Often sprouting of side shoots, and varying degrees of loss of chlorophyll from the foliage indicative of manganese and/or iron deficiency,<sup>7</sup> are also observed.

The disease is of virus origin and is primarily transmitted through seed pieces. Insect vectors and harvesting implements cause secondary infection.<sup>1-6</sup> In pilot experiments carried out at the Indian Institute of Sugarcane Research, Lucknow,<sup>4,5</sup> heat therapy was found to inactivate the virus in seed material. Steeping of infected seed pieces in water at 50° C. for 2½ to 3 hours depending on the thickness of the cane and also keeping the seed pieces in hot air at 54° C. for 8 hours in an airtight chamber were tried. Both treatments were equally effective in inactivating the virus. However, it was observed that the percentage of escapes in the former case was high possibly because it was difficult to ensure uniform heating of all the pieces treated in a lot. Further it was also observed that buds treated in hot water were easily damaged in handling because of softening resulting from the treatment. Hot-air treatment on the other hand was free from these drawbacks and was therefore preferred.

A suitable hot-air treatment unit was designed and fabricated. This consists of an airtight chamber in which air was electrically heated to the desired temperature and circulated by means of a fan between layers of seed cane spread on horizontal racks spaced 6 cm. apart. The seed material was maintained at a constant temperature of 54° C. for 8 hours. The treated material was then cut into setts with a sterilised knife and soaked in an aqueous solution of ethoxyethyl mercuric chloride (0.003% mercury) for 30 minutes. The setts were then spread in a layer one cane thick on a well-prepared seedbed, covered with a thin blanket of soil and lightly irrigated. When the prevailing temperature was low, the seedbed was covered with a thin polythene film. 4 to 6 weeks old plants from the above nursery were transplanted in experimental plots. This technique was employed to ensure a uniform population in all the experimental plots.<sup>2,3</sup> Suitable untreated checks similarly transplanted from a nursery were maintained. Subsequent cultural operations, irrigation and fertiliser application for all plots were the same. All plots including the checks were sprayed fortnightly with a 0.1% Endrin or Malathion\* to

eliminate insect vectors and thereby, secondary infection.<sup>6</sup>

Germination in the nursery, the height and girth of plants in the transplanted plots, the number of millable canes harvested and the incidence of GSD were recorded (Table I).

TABLE I  
*Performance of the crop raised from GSD-affected seed pieces of sugarcane with hot air 54° C. for 8 hours prior to planting*

Varieties and items	Treated	Untreated	t
Co. 312			
Height (cm.)	187.1	173.3	2.567*
Girth (cm.)	2.1	1.9	2.568*
Per cent increase in yield over check	26.7	..	..
Co. 453			
Height (cm.)	245.9	237.4	1.082
Girth (cm.)	2.3	1.9	3.597‡
Increase in yield (%)	102.1	..	..
Co. S. 510			
Height (cm.)	226.1	208.0	2.404*
Girth (cm.)	2.0	1.7	3.608‡
Increase in yield (%)	73.0	..	..
C.P. 49/50			
Height (cm.)	177.7	162.4	2.502*
Girth (cm.)	2.3	2.1	2.767‡

‡, †, \* indicate that differences are statistically significant at 0.1%, 1.0%, 5% levels respectively. Field trials were not replicated; so data for these could not be analysed statistically.

The germination in treated canes was 3 to 18% lower than in untreated ones. Mechanical damage to buds in handling was in most cases found to be the cause.

The data in Table I show clearly that inactivation of the virus was obtained as a result of the treatment and that the resulting crop was free from GSD. The plants raised from hot-air-treated setts were normal in appearance and growth whereas those from untreated setts gave rise to plants with typical symptoms of GSD (Fig. 1). The increase in yield obtained is sufficient to warrant advocacy of large-scale adoption of this treatment. The above treatment is known to inactivate the virus of ratoon stunting disease also<sup>4</sup> and possibly the increased yield recorded here is the cumulative result of the control of both diseases.

To obtain desired results it is necessary that:

- (1) the temperature in the heat treatment unit be maintained constant at 54° C.;
- (2) there should be a free circulation of air;
- (3) the chamber should be airtight so that continuous escape of moisture-laden air does not result in desiccation of the seed material;
- (4) the material treated should be free from



fungal infections and insect damage; (5) the treated material be planted immediately.



FIG. 1. Plants from hot-air-treated (left) and untreated sugarcane setts.

It is proposed to heat treat only seed material required for nucleus seed plots. GSD-free seed material can be multiplied from the nucleus stock to provide certified disease-free seed for cultivators.

Thanks are due to Shri S. K. Saxena for his help in analysing experimental data.

Indian Institute of  
Sugarcane Research,  
Lucknow-2, June 29, 1968.

KISHAN SINGH.

\* Endrin: Hexachloro-epoxy-octahydro-endo-dimethanonaphthalene.

Malathion: 0, 0, dimethyl-dithio-phosphate (of diethyl mercapto-succinate).

1. Chona, B. L., Capoor, S. P., Varma, P. M. and Seth, M. L., *Indian Phytopath.*, 1960, 13, 37.
2. Manjhaiya, H. N., *Sugar. J.*, 1957, 20, 4.
3. Panje, R. R. and Gill, P. S., *Indian Sugar*, 1963, 12, 737.
4. Singh, Kishan, *Ibid.*, 1967, 17, 181.
5. — and Shukla, U. S., *Annual Report, Indian Institute of Sugarcane Research*, 1964, p. 137.
6. — and —, *Proc. Intern. Symposium Plant Path.*, New Delhi (Abs.), 1966, p. 28.
7. —, — and Srivastava, S. C., *Indian Phytopath.*, 1967, 20, 351.
8. Vasudeva, R. S., *Commonwealth Phytopath.*, *Newsletter*, 1955, 1, 2.

## A NEW *CERCOSPORA* LEAF SPOT OF CARDAMOM

DURING his regular visits to the Agricultural Research Stations at Mudigere and Dharwar and to parts of Coorg, over the past two years, the senior author noticed the occurrence in severe forms of a leaf spot disease on cardamom [*Elettaria cardamomum* (L.) Maton]. The disease was found on all the three major cultivars, viz., 'Malabar', 'Bengal' and 'Assam' as well as on the local selections grown in Mysore State. Detailed studies on the disease revealed that it is caused by a species of the fungus genus *Cercospora* Fres.

The earliest symptoms of infection appear as water-soaked linear lesions, which soon turn muddy-red, more or less rectangular in shape, running along and bound by leaf veins, 0.5 to 2 mm. in width and one to several cm. in length. On the upper surface of the leaf the spots turn dark brown with dirty white, small and oblong patches in the centre. On the lower surface of the leaf the spots appear greyish to dull brown with less well-defined margin. On each leaf several hundred spots appear, often several of them running together to cover a large portion of the blade. As the disease advances the affected lesions turn greyish-brown and dry up in patches. In some blades the diseased tissues may give way resulting in shedding of the blade. In the disease-affected garden most plants are found infected and on each plant most of the blades, except the youngermost two or three leaves, are affected by the fungus. The affected plants are relatively smaller in size, with smaller blades and poor yield.

The leaf spots when examined under the microscope revealed the fungal infection. Transverse sections of the leaf passing through the affected tissues brought out the characters of the fungus (Fig. 1). The conidiophores arise in clusters from the innate many-celled dark brown stroma. They are mostly found on the upper leaf surface and are simple, rarely branched, septate, straight or curved, geniculate and often undulate at the apex and light brown coloured. They measure  $17.5-56.0 \times 5.25-3.5 \mu$  (average  $38.5 \times 3.9 \mu$ ). The conidia are formed only sparingly and considerable difficulty was experienced in obtaining sporulation of the fungus even in the humid chambers. The conidia, when formed, are hyaline, characteristically linear, indistinctly septate with 3-6 septa and mostly



curved with obtuse base,  $37.0-105.0 \times 1.75-2.5 \mu$  (average  $59.5 \times 1.9 \mu$ ).

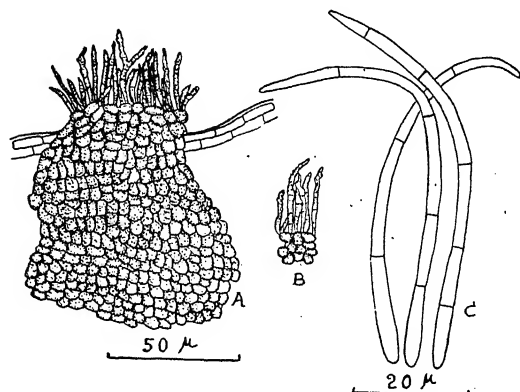


FIG. 1. A. Section through the leaf infection showing the stroma and conidiophores arising out of it; B. A cluster of conidiophores; C. Hyaline, linear, septate conidia.

Of the several species of *Cercospora* reported on members of Zingiberaceae, to which this host belongs, only two, viz., *C. curcumae* Govindu and Thirum.,<sup>1</sup> and *C. zingiberi* Togashi and Katsuki<sup>2</sup> possess hyaline conidia. A comparison of the characters of the present fungus indicated that it mostly agreed with *C. zingiberi*, except that, on cardamom the conidiophores were rarely branched, and differed from *C. curcumae* in its conidial and conidiophore characters and is, therefore, identified as *C. zingiberi* Togashi and Katsuki. This fungus has not so far been reported on cardamom in India though it has been reported on *Zingiber mioga* Rosc. in Japan,<sup>3</sup> but not on this or any other host in this country.

The authors are thankful to the USDA Far Eastern Regional Research Office, New Delhi, for financing a research project under PL 480 programme under which the present study was carried out.

University of Agrl. Sciences,  
Bangalore-24,  
June 28, 1968.

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V. S. SESHADRI.  
K. A. LUCY CHANNAMMA.

1. Thirumalachar, M. J. and Govindu, H. C., *Syd. ovia*, 1956, 10, 275.
2. Chupp, C., *A Monograph of the Fungus Genus Cercospora*. Ithaca, New York, p. 608.
3. Togashi and Katsuki, S., *Bot. Magazine*, Tokyo, 1952, 65, 25.

**GYMNEMA ALTERNIFLORUM (LOUR.)  
MERR. ASCLEPIADACEAE, AN  
ADDITION TO THE FLORA OF  
MADRAS**

DURING renovation of some of C.E.C. Fischer's early collections in the Herbarium of the Forest Research Centre, Coimbatore, a specimen from Alagar Hills, Madurai, marked *Gymnema sylvestre* Br. did not appear to be correctly identified. This was referred to the Central National Herbarium, Calcutta, where it was recognised as *Gymnema alterniflorum* (Lour.) Merr. In the regional Herbarium of the Botanical Survey of India, Coimbatore, a specimen, also from Alagar Hills, originally labelled *Gymnema elegans* W. and A. had been subsequently, correctly annotated *G. alterniflorum* (Lour.) Merr. According to Merrill (who refers to this under its synonym *G. affine* Decne.) the plant which was of Chinese origin was cultivated in the Botanical Garden at Calcutta, prior to 1844. However, no manual on the flora of India appears to have included this species, which is now found in Alagar Hills. Hence, this is now reported, with a short description as an addition to the flora of Madras.

*Gymnema alterniflorum* (Lour.) Merr. in *Trans. am. Phil. Soc.*, 1935, n.s. 24 (2): 318.  
*Apocynum alterniflorum* Lour., *Fl. Cochinch.*, 1790, 168.  
*Gymnema affine* Decne. in *DC Prodr.*, 1844, 8: 622.

Bushy climber. Stem and branches glabrous, lenticellate, Leaves petiolate, ovate, acuminate, glabrous, glossy above. Flowers axillary, umbellate, white, inodorous. Calyx 5-lobed, lobes ovate. Corolla campanulate, longer than the calyx, 5-fid; corolla tube enclosing the stamens. Stigma lobed. Follicles 2, many seeded.

Its prominently lenticellate smooth branches; glabrous glossy leaves and white flowers, distinguish this species from *Gymnema sylvestre* Br.

Madras.—Madura Dist. Alagar Hills, 9-11-1911, C.E.C. Fischer 3165; on the way to Peria-aruvi, Alagar Hills, 21-9-1957, K. Subramanyam 4336.

Forest Research Centre,  
Coimbatore, July 24, 1968.

K. N. SUBRAMANIAN.

**Neurological  
Control Systems:  
Studies in Bioengineering****By Lawrence Stark**

Professor of Physiological Optics, University of California at Berkeley  
With a Foreword by Warren McCulloch, Research Laboratory for  
Electronics, Massachusetts Institute of Technology, Cambridge,  
Mass.

Dealing mainly with an engineering science approach to four neurological motor feed-back systems—the pupil, the lens, eyeball rotation, and hand movement—this volume's experimental approach provides new, ethical methods to deal with the awake, intact brain rather than classical decerebrate and anesthetized animals.

428 pages      September 1968      PP      \$ 17.50

**Physiology and  
Pathology of  
Membrane Digestion****By A. M. Ugolev**

Director, Laboratory of Physiology of Nutrition, Pavlov Institute of  
Physiology, Academy of Sciences of the USSR  
Translated from Russian and with a Foreword by J. A. Stekol  
Head, Department of Physiological Chemistry and Nutrition,  
The Institute for Cancer Research, Philadelphia, Pennsylvania

Presents experimental evidence confirming the existence of membrane digestion (contact or surface) of the main food-stuffs, and explains its significance in the normal development of organisms and in pathological states where digestion and the consequent use of foodstuffs is altered.

226 pages      1968      PP      \$ 15.00

**Insect Vision****By G. A. Mazohkin-Porshnyakov**

Senior Investigator and Professor of Entomology, Institute of Information,  
Academy of Sciences of the USSR  
Translated from Russian by R. Masironi and L. Masironi  
Department of Physiology, Division of Basic Health Sciences,  
Emory University, Atlanta, Georgia  
Translation edited and with a Foreword by Timothy H. Goldsmith  
Department of Biology, Yale University  
With a Preface by Talbot H. Waterman, Harvard University

The most comprehensive to date on the subject, this monograph provides a detailed description of the visual system of insects. It covers the anatomy and physiology of both compound eyes and ocelli, insect behaviour as it is influenced by visual stimuli, and specific topics on the control of insect populations through the use of light traps.

Approx.      309 pages      4th quarter 1968      PP      \$ 22.50

**Biomedical  
Applications of Gas  
Chromatography  
Volume 2****Edited by Herman A. Szymanski**

Chairman, Dept. of Chemistry, Canisius College, Buffalo, New York

The second volume in an important series continues to survey biomedical applications of gas chromatography. Among the topics covered by leading specialists in the field are urinary acids, dopamine, carbohydrates, and amino acids. All the articles represent the efforts of some of the most prominent scientists working with advanced equipment. This book will be an important reference for those working in gas chromatographic applications to biology and biochemistry.

198 pages      September 1968      PP      \$ 12.50

**consultants bureau/plenum press**

Divisions of Plenum Publishing Corporation  
227 W. 17th ST., NEW YORK, N. Y. 10011.

## REVIEWS AND NOTICES OF BOOKS

**Molecular Orbital Theories of Bonding in Organic Molecules.** By Robert L. Flurry, Jr. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016), 1968. Pp. +334. Price \$17.75.

The purpose of this work is twofold: first, to provide a conceptual understanding of the principles of chemical bonding as explained by molecular orbital theory, and secondly, to provide a working knowledge of the methods in common usage for applying molecular orbital theory to moderately large molecules. The orientation of the book toward organic molecules stems partly from the fact that these are the systems for which the semiempirical molecular orbital methods are most highly developed, and partly from the fact that this is the primary orientation of the author's own research interests.

The contents of this book are: Introduction; Free Electron Theory; Simple LCAO Theory; Perturbation Methods; Solving LCAO Equations; Group Theory and Symmetry Orbitals; Atomic Theory; Self-Consistent Molecular Orbital Methods; Sigma Bonds; and Applying the Theories.

The level of presentation is within the grasp of advanced undergraduates, yet the coverage makes the book useful to graduate students and those who have completed their formal education.

C. V. R.

**Progress in Analytical Chemistry (Vol. 1)—X-Ray and Electron Methods of Analysis.** Edited by H. van Olphen and William Parrish. (Plenum Press, New York), 1968. Pp. x + 164.

This book is the first in the series designed to cover selected topics presented at the Eastern Analytical Symposium in the fall of each year. Written by well-known authors in their fields, each paper presents advances in analytical chemistry to research workers in this and allied disciplines.

The contents of this volume are: X-Ray Diffractometry Methods for Complex Powder Patterns; Energy Dispersion X-Ray Analysis Using Radioactive Sources; Quantitative Electron Microprobe Analysis; Determination of Specific Surfaces by Small-Angle X-Ray Scattering Methods—A Brief Review; Determi-

nation of Particle-Diameter Distributions by Small-Angle X-Ray Scattering; Small-Angle X-Ray Scattering and Low-Energy Electron Diffraction Studies of Catalyst Surfaces; and The Analysis of Low-Angle Light Scattering from Simple Mixtures.

C. V. R.

**Annual Review of Pharmacology (Vol. 8).** Edited by H. W. Elliott. (Annual Reviews, Inc., 4139 El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. vii + 594. Price \$9.00.

Volume 8 of this well-known series contains the following articles: A Personal Biography of Arthur Robertson Cushny, 1866-1926; Highlights of Soviet Pharmacology; Some Relationships Between Chemical Structure and Pharmacological Activities; Pharmacokinetics; Pharmacology of the Coronary Circulation; Drugs and the Mechanical Properties of Heart Muscle; Renal Pharmacology; The Use of Combinations of Antimicrobial Drugs; Drug Action on Digestive System; The Metabolism of the Alkylphosphate Antagonists and its Pharmacologic Implications; Chemotherapy of Animal Parasites; Physiologic and Pharmacologic Considerations of Biogenic Amines in the Nervous System; Agents which Block Adrenergic  $\beta$ -Receptors; Invertebrate Pharmacology; Pharmacology of Peptides and Proteins in Snake Venoms; Thyrocalcitonin; Extrarenal Excretion of Drugs and Chemicals; Non-steroid Antiinflammatory Agents; False Adrenergic Transmitters; Fluorides and Man; Toxins of Marine Origin; Genetic Factors in Relation to Drugs; Developmental Pharmacology; Pharmacology of Reproduction and Fertility; Human Pharmacology of Antipsychotic and Antidepressant Drugs; and Review of Reviews.

C. V. R.

**Structure and Function of Membranes:**

**British Medical Bulletin (Vol. 24, Number 2).** Edited by D. H. Northcote. (British Medical Bulletin, 97/99, Park Street, London W. 1), Pp. 99-186. Price £ 2 or \$ 6.50.

The May 1968 number of *British Medical Bulletin* is a symposium of papers on the structure and function of membranes. There are 16 papers contributed by 19 authors who are engaged in active research in the problems

they review. The papers represent a cross-section of current research in the field of structure and function of animal-cell and plant-cell membranes. They include papers on the chemistry of membranes, their ultrastructure, bimolecular and micellar organization, membrane adenosine triphosphatase and cation transport, nervous conduction and the transport of sugars, membranes of mitochondria and their function in transport, vacuoles and lysosomes, effect of pharmacologically active compounds on membranes, membrane functioning in preparations from the mammalian brain, immunological actions at the cell surface, the properties of the external layer of insects, and sarcoplasmic reticulum in vertebrate muscle.

A. S. G.

### ANNOUNCEMENTS

#### Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Physics to Shri P. S. Krishna Mohana Rao; Ph.D. degree in Chemistry to Shri J. Meena Rao; Ph.D. degree in Physiology to Shri G. Joseph and Ph.D. degree in Botany to Shri B. G. Srinivasa Rao.

M. S. University of Baroda has awarded the Ph.D. degree to the following for subject noted against each:

Shri A. B. Darji (Physics), Shri Mohammed Abdur Razack Siddiqui Khazi (Zoology), Shri Arvind Kalyanji Desai (Zoology), Shri Shashikant Vandhravan Shah (Physics), Kumari B. Kanakalakshmi Nair (Chemistry), and Shri Rambhai Nathubhai Patel (Education).

Osmania University has awarded the Ph.D. degree in Botany to Smt. Joginder Kaur.

#### Colloquium on Cosmic Ray Studies in Relation to Recent Developments in Astronomy and Astrophysics

A Colloquium on "Cosmic Ray Studies in Relation to Recent Developments in Astronomy and Astrophysics" will be held at the Tata Institute of Fundamental Research, Bombay, from Monday, November 11 to Saturday, November 16, 1968 both days inclusive.

About 20 scientists including about 10 from abroad, engaged in research on Cosmic Rays, Astronomy, Astrophysics and Cosmology will lecture in this Colloquium.

Further information can be had from Prof. R. R. Daniel, Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 5.

#### Symposium on Mining Industry in South India

A Three-Day Symposium on the above subject will be held in Bangalore from November 28th to 30th, 1968. The main theme of the Symposium is to review the progress of mining industry in South India and highlight the possibilities for rapid development by optimum utilisation of resources and modern techniques.

The Symposium is jointly sponsored by the Geological Society of India, and the Institution of Engineers (India) Mysore Centre, Andhra Pradesh Centre and Neyveli Sub-Centre.

For further information please write to: Sri. S. G. Ramachandra, Hon. Secretary, Institution of Engineers (I) Mysore Centre, No. 3, Vidhana Veedhi, Bangalore-1.

#### Desalination Information Centre

On the recommendations of the Conference on Water Desalination held at the Central Salt and Marine Chemicals Research Institute, Bhavnagar, from 16th to 18th November 1967, Desalination Information Centre has been established at the Institute from 1st January, 1968. The activities of the Information Centre include issue of a bulletin *Desalination News* and answering technical enquiries on desalination.

#### ERRATUM

In the article "Dry Matter Production in Sun and Shade Leaves and a Simple Method for the Measurement of Primary Productivity" published in *Current Science*, Vol. 37, No. 11, pp. 306-307, June 5, 1968, in Table I all the values should be read as g./20 m.<sup>2</sup> in place of g./m.<sup>2</sup>.

#### Books Received

*Fatty Acids and Their Industrial Applications.*

Edited by E. S. Pattison. (Marcel Dekker, Inc., New York 10016), 1968. Pp. xii + 390. Price \$8.00.

*Molecular Orbital Theories of Bonding in Organic Molecules.* By R. L. Flurry Jr.

(Marcel Dekker, Inc., New York 10016), 1968. Pp. x + 334. Price \$17.75.

*The Structural Basis of Antibody Specificity.*

By A. L. Crossberg and D. Pressman. (W. A. Benjamin, Inc., New York 10016), 1968. Pp. xvii + 279. Price \$16.75.

*Advances in Chromatography* (Vol. 6). Edited by J. Calvin Giddings and Roy A. Keller. (Marcel Dekker, Inc., New York 10016), 1968. Pp. xix + 335. Price \$16.75.

# SORPTIVE PROPERTIES OF FIBROUS SILICA GEL (SANTOCEL C) ACTIVATED AT DIFFERENT TEMPERATURES

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THE mode of preparation and treatment of sorbents have been reported by earlier workers to influence the nature and extent of sorption. Precipitated silica gel obtained by mixing sodium silicate and ammonium chloride solutions has been found to differ markedly in shape of the isotherms and the size and position of the hysteresis loops from glassy silica gel obtained from set silicic acid jelly of a mixture of sodium silicate and hydrochloric acid solutions.<sup>1</sup> Weiser and collaborators<sup>2</sup> have reported that if hydrous oxide gels are prepared by mixing boiling solutions of the reactants, the hysteresis effect, obtained in the sorption and desorption of water, is eliminated. Such elimination has been reported with silica gel in particular. Krishnappa and others<sup>3</sup> have studied that when silica gel is activated at different temperatures varying from 35° to 1,000°, its sorptive capacity for water first decreases upto 140°, remains practically constant from 140° to 500° and suffers a marked decrease at 1,000°.

The new form of silica gel—fibrous silica gel (Trade name Santocel C) produced by Monsanto Company, U.S.A.—has been used in the earlier investigations by the authors.<sup>4</sup> With this new form of silica gel, the effect of variation of the activation temperature on the sorptive properties has been studied and presented in this paper.

The study of sorption-desorption hysteresis of methyl, ethyl, *n*-propyl, *n*-butyl and *n*-amyl alcohols at 35° on fibrous silica gel activated at 250° has been presented in the previous paper.<sup>4</sup> In the present paper a similar study has been made with the same sorbates at 35° on fibrous silica gel activated at 450° and the results are compared. The hysteresis loops of water and carbon tetrachloride with the two gels have also been included. The quartz fibre spring technique<sup>5,6</sup> has been employed in the present investigations.

## RESULTS AND DISCUSSIONS

In all the cases the hysteresis loop is permanent and has been reproduced upto the 3rd cycle of sorption and desorption. In the case of ethyl alcohol, sorptions and desorptions

were tried upto 5th cycle. The permanent and reproducible hysteresis loops obtained with the two samples activated at 250° and 450° are shown in Figs. 1 and 2 respectively to facilitate a comparative study. In these figures the isotherms are presented by plotting the volume of sorbate taken per 100 g. of gel against the relative vapour pressure.

At the end of the first cycle of sorption and desorption the gels retain some amount of water irreversibly in spite of several hours of evacuation. The amounts of bound water held by the two samples of silica gel activated at 250° and 450° are 2.5 cm.<sup>3</sup> and 1.4 cm.<sup>3</sup>/100 g. of gel respectively. The small volume of water irreversibly held may be chemisorbed. The sorptive capacities of the two samples at saturation pressure for the different sorbates are given in Table I.

TABLE I  
Sorptive capacities of fibrous silica gel in  
cm.<sup>3</sup>/100 g.

	Activated at 250°	Activated at 450°
Water	64.0	62.2
Carbon tetrachloride	50.0	56.8
Methyl alcohol	33.0	52.0
Ethyl alcohol	33.3	61.2
<i>n</i> -Propyl alcohol	38.7	54.6
<i>n</i> -Butyl alcohol	19.0	21.4
<i>n</i> -Amyl alcohol	21.0	21.6

When the temperature of activation of the silica gel is raised from 250° to 450°, the sorption values at saturation pressure of methyl, ethyl and *n*-propyl alcohols have appreciably increased, that of carbon tetrachloride has increased slightly, whereas the values of other sorbates remain practically the same.

## APPLICATION OF BET EQUATION AND MONOLAYER CAPACITIES

Excepting water and carbon tetrachloride, the sorption isotherms of the five aliphatic alcohols have clearly defined "knees". According to BET theory,<sup>7</sup> the "knee" signifies the transition from monomolecular to multimolecular sorption. The BET equation has been applied to the isotherms. BET plots were

straight lines. From the slope and intercept of the lines, the monolayer capacities  $x_m$  have been calculated. The value of monolayer capacity was also read out directly from the isotherms with reasonable accuracy<sup>10</sup> and is denoted by  $x_m$ . The values of monolayer capacities  $x_m$  and  $x_t$  for the five alcohols and the relative vapour pressures at which the monolayers are fully formed have been given in Table II.

TABLE II

Monolayer capacities  $x_m$  and  $x_t$  in g. per g. of sorption and the corresponding relative vapour pressures

	Silica gel activated at 250°			Silica gel activated at 450°		
	$x_m$	$x_t$	$P/P_0$	$x_m$	$x_t$	$P/P_0$
Methyl alcohol	0.016	0.016	0.05	0.017	0.016	0.05
Ethyl alcohol	0.018	0.017	0.05	0.022	0.023	0.06
<i>n</i> -Propyl alcohol	0.028	0.028	0.10	0.025	0.025	0.10
<i>n</i> -Butyl alcohol	0.035	0.032	0.13	0.034	0.033	0.10
<i>n</i> -Amyl alcohol	0.041	0.041	0.22	0.037	0.037	0.16

The agreement is good between the values of  $x_m$  and  $x_t$  for each alcohol with the two samples of gel activated at 250° and 450°.

#### MONOLAYER CAPACITY AND SPECIFIC SURFACE

From the monolayer capacity, the specific area of the sorbent is calculated as described in the earlier paper.<sup>4</sup> The molecular diameter  $D_m$  is assumed for calculating the molecular cross-section. Knowing the molecular cross-sections of the five aliphatic alcohols and their monolayer capacities  $x_m$ , the specific

surface areas of the two gels are obtained. The results are shown in Table III.

TABLE III

Specific surface of fibrous silica gel considering alcohol molecules as spheres

	Molecular cross-section in Å <sup>2</sup>	Specific surface in m <sup>2</sup> /g. of fibrous silica gel	
		Activated at 250°	Activated at 450°
Methyl alcohol	31.2	65.5	68.4
Ethyl alcohol	37.0	63.4	76.3
<i>n</i> -Propyl alcohol	31.4	86.7	98.7
<i>n</i> -Butyl alcohol	36.8	103.4	99.6
<i>n</i> -Amyl alcohol	49.2	175.4	101.7

In both the gels, the value of the specific surface goes on increasing from methyl to *n*-amyl alcohol. This is due to the incorrectness of assuming the five aliphatic alcohol molecules as spheres. Actually the aliphatic alcohol molecules are linear in shape increasing in length from methyl alcohol to *n*-amyl alcohol. It is not strictly correct to assume the cubical or spherical shape for the molecules. The linear adsorbed molecule can be held on the surface either perpendicular or parallel to the surface. Assuming that the alcohol molecule is a rectangular rod, it is necessary to calculate the cross-section area of the rod and also the area of one of the four sides along the length of the rod.

The thickness<sup>10</sup> of the hydrocarbon chain is 4.55 Å. Therefore, the thickness of all the five alcohols is assumed to be the same. From the volume of the molecule  $D^3$  and its thickness 4.55 Å, the length of the linear molecule can be calculated. The area of the end and the side along the length of the linear molecule are also calculated and are shown in Table IV.

TABLE IV

Specific surface of fibrous silica gel considering alcohol molecules as linear

	Diameter in Å	Length of the molecule in Å	Cross-section in Å <sup>2</sup>	Area of side in Å <sup>2</sup>	Specific surface in m <sup>2</sup> /g. of gel			
					Activated at 250°		Activated at 450°	
					Molecules perpendicular to surface	Molecules parallel to surface	Molecules perpendicular to surface	Molecules parallel to surface
Methyl alcohol	4.6	4.7	20.7	21.4	64.1	66.3	66.9	69.2
Ethyl alcohol	5.2	6.8	20.7	33.4	48.5	72.4	53.4	87.2
<i>n</i> -Propyl alcohol	5.6	8.5	20.7	36.5	57.2	106.8	57.2	106.8
<i>n</i> -Butyl alcohol	6.8	10.4	20.7	47.5	59.4	136.2	57.2	131.2
<i>n</i> -Amyl alcohol	6.3	12.1	20.7	55.0	57.3	152.0	52.4	189.0

The specific areas calculated by assuming both the modes of sorption have also been shown in the table.

The following interesting conclusions emerge from the results of Table IV. In both the gels, the values of specific surface obtained for the five alcohols are practically the same if oriented sorption perpendicular to the surface of the linear alcohol molecules is assumed. If oriented sorption parallel to surface is assumed, the value of the specific surface goes on increasing from methyl to *n*-amyl alcohol. Therefore it follows that sorption of the five aliphatic normal alcohols in the monolayers on the surface of fibrous silica gels activated at 250° and 450° are of the oriented type perpendicular to surface.

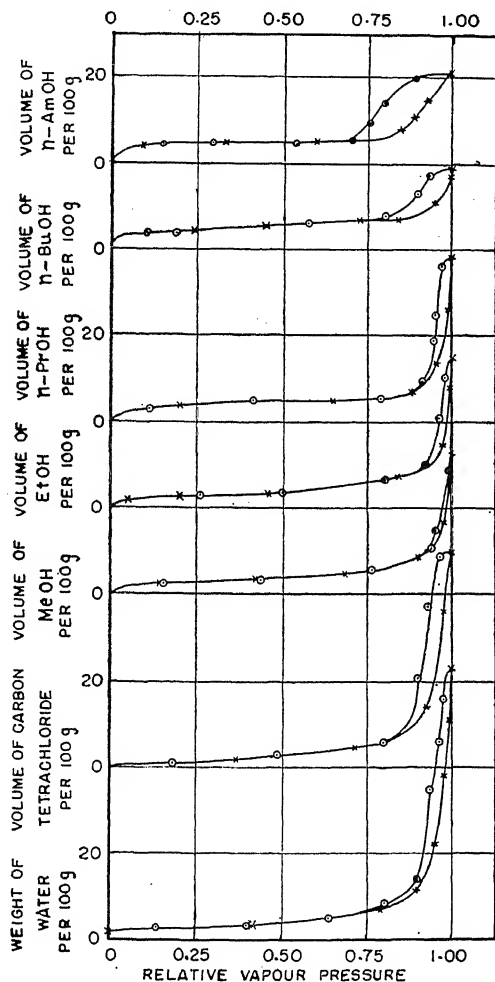


FIG. 1. Sorption and desorption on fibrous silica gel activated at 250° of water, carbon tetrachloride, methyl, ethyl, *n*-propyl, *n*-butyl and *n*-amyl alcohols.

Secondly, for this oriented type of sorption perpendicular to surface, the specific surface values obtained of the gel activated at 250° are almost the same as those of gel activated at 450°. Variation in the temperature of activation has not made any difference in specific surface area of the gel.

#### SORPTION-DESORPTION HYSTERESIS

Figures 1 and 2 reveal that the hysteresis loops of the two gels activated at 250° and

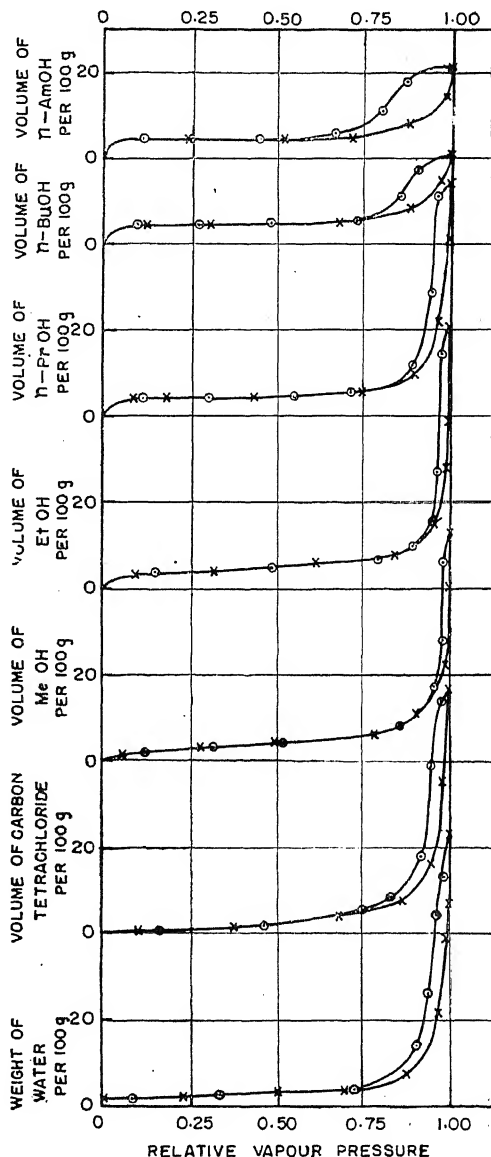


FIG. 2. Sorption and desorption on fibrous silica gel activated at 450° of water, carbon tetrachloride, methyl, ethyl, *n*-propyl, *n*-butyl and *n*-amyl alcohols.

48 for any particular alcohol are almost identical in shape and point of commencement of the loop. There are two theories of sorption and desorption hysteresis—Cohan's theory<sup>11</sup> and the Cavity theory.<sup>12</sup> The applicability of Cohan's theory to the hysteresis loops of the five alcohols with silica gel activated at 250° and 450° has been studied. The values of molecular diameters  $D$  obtained have been calculated and are shown along with  $D_{\text{Cohan}}$  in Table V.

TABLE V  
Molecular diameters  $D$  in Å of fibrous silica gel

	$D_{\text{Cohan}}$	$D_{\text{Cavity theory}}$	
		With gel activated at 25°	With gel activated at 450°
Water ..	3.5	15.5	14.6
Carbon tetrachloride ..	8.1	43.3	33.6
Methyl alcohol ..	4.8	52.2	52.2
Isopropanol ..	7.1	47.2	47.2
Diethylamine ..	7.6	41.2	41.2
Acetone ..	6.0	33.2	29.3
Acetylacetone ..	6.8	33.8	35.7

In all the cases the values of  $D$  obtained by the application of Cohan's theory are higher than  $D_{\text{Cohan}}$ , indicating the inapplicability of Cohan's theory to the results.

The cavity theory postulates that hysteresis effect is due to entrapping of liquid sorbate in the cavity during desorption until the relative vapour pressure corresponding to the neck of the cavity is reached. The shape and position of the hysteresis loop depends upon the shape and size of cavities.

#### Pore Size Distribution

According to the cavity theory of hysteresis, the desorption curve of hysteresis loop indicates the neck radius and sorption curve the body radius of the cavity. The predominant neck and body radii of cavities are obtained from the midpoints of the steep parts of desorption and sorption curves respectively. The isotherms of water have been employed. Body and neck radii have been calculated by the application of Kelvin equation. The values of both the samples are shown in Table VI. The smallest neck radius corresponding to the point of inception of the hysteresis loop is also shown.

TABLE VI  
Pore size distribution in Å of fibrous silica gel

	Smallest neck radius	Predominant neck radius	Predominant body radius
Gel activated at 250°	31.0	150.0	380.0
Gel activated at 450°	29.2	137.4	393.4

The results show that the values of smallest neck radius, the predominant cavity body and neck radii remain almost the same on heating fibrous silica gel from 250° to 450°. Higher temperature has not changed markedly the porous structure of fibrous silica gel. Similar results have been reported by Milligan and Rachford.<sup>13</sup> In their silica gel, hysteresis loop is not destroyed by moderate or even excessive heat treatment. However, heat of 400° to 600° actually increased the area of the loop.

#### ACKNOWLEDGEMENTS

The authors are thankful to Prof. V. Lakshminarayanan, Director, for encouragement and facilities in the work, the Ministry of Education, Government of India, for the award of a scholarship to one of the authors (BD) and Monsanto Company, Missouri, U.S.A., for supplying a gift sample of Santocel C.

1. Krishnappa, T., Subba Rao, K. and Sanjiva Rao, B., *Proc. Ind. Acad. Sci.*, 1947, **25**, 181.
2. Weiser, Milligan and Holes, *J. Phys. Chem.*, 1942, **46**, 586 & 1051.
3. Krishnappa, T., Subba Rao, K. and Sanjiva Rao, B., *Proc. Ind. Acad. Sci.*, 1947, **25**, 174.
4. Subba Rao, K. and Das, B., *Curr. Sci.*, 1968, **37**, 274.
5. —, *J. Phys. Chem.*, 1941, **45**, 500.
6. — and Das, B., *Ibid.*, 1968, **72**, 1223.
7. Brunauer, S., Emmett, P. H. and Teller, E., *J. Am. Chem. Soc.*, 1938, **60**, 309.
8. Emmett, P. H. and Brunauer, S., *Ibid.*, 1937, **59**, 1553.
9. Gregg, S. J. and Sing, K. S. W., *Adsorption, Surface Area and Porosity*, Academic Press, London and New York, 1967, p. 54.
10. Moelwyn Hughes, E. A., *Kinetics of Reactions in Solutions*, Clarendon Press, Oxford, 1947, p. 7.
11. Cohan, L. H., *J. Am. Chem. Soc.*, 1933, **60**, 433.
12. McBain, J. W., *Ibid.*, 1935, **57**, 699.
13. Milligan, W. O. and Rachford, H. H., Jr., *J. Phys. and Colloid Chem.*, 1947, **51**, 333.



## TAPIOCA SPENT PULP AS AN INGREDIENT IN POULTRY FEED

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### INTRODUCTION

IN view of the growing shortage of food for man and animals, particularly in countries like India, many attempts are being made to augment its production by better utilization of the available resources. One of the ways of increasing the food for human consumption is through livestock, for which new sources of feed supplements such as treated organic wastes of suitable nature may be found. One such material, activated sludge containing proteins and other substances especially vitamin B<sub>12</sub>, as a feed supplement for poultry was recently examined by us.<sup>1</sup> More recently we have collected evidence on the possible use of tapioca spent pulp as an energy-providing ingredient in the poultry feed, and the present communication deals with this evidence.

### SOME ASPECTS OF TAPIOCA

*The tapioca plant.*—Tapioca (Cassava, a tuber plant) is one of the miscellaneous food crops of South India.<sup>2</sup> This is a predominantly tropical plant, reported to be a native of Brazil (South America) where it has been grown from ancient times.<sup>2</sup> In India, for over a century this plant has been grown as a subsidiary food crop, particularly in Kerala and Madras States.<sup>3,4</sup> During the Second World War, due to short supplies of starch and rice, the cultivation of tapioca received an impetus, and in 1958 the area under this crop in this country was about 614 thousand acres yielding about 1,768 thousand tons of the crop.<sup>3</sup> Information on production and consumption of tapioca starch in textile industry is also available.<sup>3</sup>

*The toxic substance in tapioca and its elimination.*—There are two varieties of cassava: the sweet variety and the bitter variety. Of these, the bitter variety (*Manihot utilisima* Pohl.) is preferred for the production of starch

from its tuberous roots.<sup>3</sup> This variety contains more prussic acid or hydrocyanic acid,<sup>3,5</sup> a toxic substance "first recorded by Boutron-Charlard in 1836, though the fact that the toxicity of this material was due to a volatile constituent was first established by Henry and Boutron-Charlard in 1833".<sup>6</sup> A cyanogenetic glucoside, linamarin, and an enzyme linase which hydrolyses it are also present in the tuber.<sup>3</sup> The toxic substance is present more near the cortical layers than in the interior of the roots.<sup>2</sup> The pulp from six varieties of cassava grown in Nigeria contained from 29 to 213 mg HCN per kg. fresh matter. In general, there was more HCN when there was no rainfall. Values for peel, which constituted 18% of the whole root, were from 5 to 10 times greater than those for pulp.<sup>7</sup>

The major part of the toxic substance in the tapioca tuber can be eliminated by peeling the tuber and washing, sun-drying after slicing or cooking with water for 5 minutes.<sup>3</sup> Nutritional experiments with tapioca have been carried out.<sup>8-13</sup>

*Tapioca spent pulp.*—In the extraction of starch and sago from tapioca a fibrous waste is obtained as a by-product (yield 10 to 20%),<sup>14</sup> which is free from the toxic substance and contains a considerable amount (56.2%)<sup>14</sup> of starch. This waste, if it is not properly disposed of, undergoes putrefactive changes and causes atmospheric pollution. Such a problem in environmental hygiene and sanitation arose at one of the industrial establishments.<sup>15</sup> Attempts have been made to extract a part of the starch or to use the whole material as a cattle feed or as fuel.<sup>14</sup>

The studies on the nutritive value of tapioca spent pulp as a cattle feed indicated (a) that the total digestible nutrient value and starch equivalent worked out to be 71.12 and 68.09 kg. per 100 kg. tapioca spent pulp, and (b) that inclusion of the spent pulp in the

\* Deceased.

TABLE I  
Chemical composition of the ingredients of the poultry mash  
(Per cent on oven-dry basis)

Ingredient	Organic matter	Crude protein	Ether extract or crude fat	Crude fibre	Nitrogen-free extract	Total carbohydrates	Ash or mineral matter	Calcium (Ca)	Phosphorus (P)
Tapioca spent pulp	95.87	2.25	0.23	14.39	78.95	93.34	4.13	0.29	0.05
Ragi flour	91.77	7.95	1.05	5.14	77.63	82.77	8.23	0.33	1.57
Wheat bran	94.53	16.15	3.48	12.12	62.78	74.90	5.47	0.08	1.06
Yellow maize	98.11	10.53	3.85	2.25	81.48	83.73	1.89	0.03	0.38
Rice polish	83.55	15.67	14.85	10.37	42.66	53.03	16.45	0.16	1.81
Groundnut cake	94.23	50.25	5.82	4.95	33.21	38.16	5.77	0.10	0.56
Fish meal	73.67	55.67	8.55	1.15	8.26	9.41	26.23	8.15	7.24
Mineral mixture	..	..	..	..	..	..	80.53	24.23	9.35
Shell grit	..	..	..	..	..	..	..	38.35	..

rations of Thari cows resulted in a positive balance of nitrogen and calcium and a slight negative balance of phosphorus in the animals.<sup>16</sup>

The use of tapioca spent pulp as a feed ingredient to replace the costlier sources of energy-providing millets or cereals in the diet of laying birds has not been examined. We have carried out experiments to study the effects of partial replacement of flour of ragi (*Eleusine coracana*) by tapioca spent pulp in the diet of hens on egg-laying. These experiments and the results are briefly described here.

#### EXPERIMENTS WITH TAPIOCA SPENT PULP

**Materials and methods.**—The tapioca spent pulp used in the experiments was obtained from Messrs. Laxmi Starch Factory, Ltd., Kundara, Kerala State, to whom the authors' thanks are due. Feeding experiments were carried out at the Central Poultry Farm, Hesaraghatta, of the Department of Animal Husbandry and Veterinary Services, Government of Mysore.

The ingredients of the poultry mash were analysed for their nitrogen, crude fat, fibre, calcium and phosphorus contents by the methods recommended by the A.O.A.C.,<sup>17</sup> and the results are given in Table I. For feeding the birds the following two mashes were prepared (Table II): (i) the control mash, generally used in the farm, and (ii) the mash in which 50% of the ragi flour was replaced by tapioca spent pulp. By this substitution, the experimental mash contained 10% of the pulp and the two mashes were nearly isoproteinous and isocaloric.<sup>18</sup> The amino acid composition of the control mash and experimental mash has been worked out<sup>19</sup> in Table III on the basis of the crude protein contents given in Table II.

TABLE II  
Composition of layer mash

Ingredient	Control mash	Experimental mash
Ragi flour	..	10
Tapioca spent pulp	..	10
Wheat bran	..	10
Yellow maize	..	10
Rice polish	..	30
Groundnut cake	..	20
Fish meal	..	5
Shell grit	..	2
Mineral mixture	..	1
Others (proprietary anti-biotic mixtures, etc.)	..	2
Total	100	100
Crude protein %	19.6	19.1
Digestible crude protein %	15.7	15.3
Total digestible nutrients %	65.5	65.6

TABLE III  
Amino acid composition of the mashes

Amino acid	Control mash g./kg.	Experimental mash g./kg.
Arginine	19.99	19.75
Histidine	8.73	8.60
Lysine	8.73	8.60
Tyrosine	7.92	7.86
Tryptophane	2.27	2.18
Phenylalanine	10.55	10.23
Cystine	3.34	3.13
Methionine	3.84	3.54
Threonine	5.69	5.47
Leucine	17.98	17.36
Iso-leucine	8.25	7.86
Valine	12.00	11.57

60 six-months-old White Leghorn hens were divided into two groups of 30 each. One of these groups of birds were fed on the control mash and the other group were fed on the

TABLE IV

Egg-laying record of the birds fed on the control and experimental mash

(Number of eggs laid by a group of 30 birds on each mash is given. The average yield per day is given within brackets.)

Mash	February	March	April	May	June	July	August
Control	558 (19.2)	680 (21.9)	667 (22.2)	670 (21. )	646 (21.5)	600 (19.4)	660 (21.3)
Experimental	668 (23.0)	717 (23.1)	745 (24.8)	749 (24.2)	694 (23.1)	685 (22.1)	755 (24.4)

 $F_{1,6} = 61.98$ ; significant at 1% level.

experimental mash. Observations on the egg-laying and on the health of the birds were carried out over a period of seven months.

**Results.**—The egg-laying record of the birds on the two mashes is given in Table IV. These results indicate that there was an increase in the number of eggs laid by the birds when they were fed on the mash containing tapioca spent pulp.

The increases in the numbers of eggs laid during the seven months ranged from 5.4 to 19.7%; the average increase in egg-laying due to the inclusion of tapioca spent pulp was 11.9%. Also, during this period of observation, the birds did not show any untoward symptoms. They were healthy.

The manner in which the tapioca spent pulp exerted its beneficial effect on the hens in the increased production of eggs is not clear. The diets for the control and experimental hens were not only isoproteinous and isocaloric but also contained nearly the same amounts of calcium and other minerals (Tables I and II).

Whether the tapioca spent pulp at the dosage at which it was used contains something (unlike ragi) that is conducive to hens for egg-laying remains to be investigated.

## SUMMARY

Some aspects of tapioca have been considered, with special reference to the possible utilization of the spent pulp which is a waste material in the production of starch from tapioca. This starch waste or spent pulp may be utilized as an ingredient in poultry feed.

Experiments were carried out with White Leghorn hens over a period of seven months in order to study the effect of replacing 50% of ragi flour by tapioca spent pulp in the feed of the birds, particularly on their health and egg-laying. The birds were healthy and laid more eggs. There was, on the average, about 12% increase in the number of eggs laid as a result of inclusion of tapioca spent pulp in the feed.

## ACKNOWLEDGEMENT

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1. Pillai, S. C., Srinath, E. G., Mathur, M. L., Naidu, P. M. N. and Muthanna, P. G., *Water and Waste Treatment (London)*, 1967, 11, 316.
2. Yegna Narayan Aiyer, A. K., *Field Crops of India with Special Reference to Mysore*, Government Press, Bangalore, 1944, pp. 255-256.
3. *The Wealth of India: Raw Materials*, L-M, Council of Scientific and Industrial Research, New Delhi, 1962, 6, 286-297.
4. Balu, V. and Parpia, H. A. B., *Tapioca Macaroni Goes to the People*, Food Science Extension Service—Bulletin No. 1, Central Food Technological Research Institute, Mysore, 1958.
5. Dunstan, W. R., Henry, T. A. and Auld, S. J. M., *Proc. roy. Soc. London*, 1906, 78 B, 152.
6. *Bulletin of the Imperial Institute*, London, 1906, 4, 339.
7. Oyenuga, V. A. and Amazigo, E. O., *Nutr. Abstr. & Revs.*, 1959, 29, 792.
8. —, Murthy, H. B. N. and Swaminathan, M., *Brit. J. Nutr.*, 1954, 8, 1.
9. Murthy, H. B. N., Swaminathan, M. and Subrahmanyam, V., *Ibid.*, 1954, 8, 11.
10. Joseph, K., Narayana Rao, M., Swaminathan, M. and Subrahmanyam, V., *Ibid.*, 1958, 12, 429.
11. Klein, F. W. and Barlowen, G. V., *Nutr. Abstr. & Revs.*, 1955, 25, 850.
12. Vogt, H. and Penner, W., *Ibid.*, 1964, 34, 886.
13. — and Stute, K., *Ibid.*, 1965, 35, 541.
14. Subrahmanyam, V., Narayana Rao, M., Rama Rao, G. and Swaminathan, M., *Bull. Centr. Food Technol. Res. Inst.*, Mysore, 1965-56, 5, 80.
15. Pillai, S. C., *Report on the Treatment and Utilization of Tapioca Spent Pulp at Laxmi Starch Factory Ltd., Kundara, Kerala State*, 1963.
16. *Annual Progress Report of the Animal Nutrition Centre*, National Dairy Research Institute, Southern Regional Station, Audugodi, Bangalore, 1964-65.
17. *Official Methods of Analysis*, Association of Official Agricultural Chemists, Washington, D.C., 1960.
18. Sen, K. C. and Ray, S. N., *Nutritive Values of Indian Cattle Feeds and Feeding of Animals*, Indian Council of Agricultural Research, New Delhi, Bulletin No. 25, 1964.
19. Kuppaswamy, S., Srinivasan, M. and Subrahmanyam, V., *Proteins in Foods*, Special Report Series No. 33, Indian Council of Medical Research, New Delhi, 1958, pp. 22, 90, 210.

# EXPERIMENTAL INDUCTION OF TRIPLOID SHOOTS *IN VITRO* FROM ENDOSPERM OF *DENDROPHTHOE FALCATA* (L.f.) ETTINGS.

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THE aseptic culture of various sporophytic and gametophytic tissues has enabled us to understand their totipotency and some of the causal factors for organ differentiation. However, not much success has been achieved in inducing morphogenesis in the endosperm tissue of angiosperms. Although tissues of unlimited growth have been obtained from endosperm of several species,<sup>1-3</sup> only in the singular instance of *Exocarpus cupressiformis* Labill. (Santalaceae) has this tissue differentiated shoot buds.<sup>4</sup> The present work was initiated to explore whether or not endosperm of some other taxa has potentiality for morphogenesis *in vitro*.

Ripe fruits of the loranthaceous parasite *Dendrophthoe falcata* ( $2n=18$ ) were washed with 'Cetavlon' cetrimide-concentrate (diluted to 100 times) and surface-sterilized with 90% ethyl alcohol for about five minutes. The endosperm, together with the embryo (Fig. 1, A), was aseptically excised from the fruits and implanted on modified White's agar (0.8%) medium containing 3% sucrose (WM), and on WM supplemented with indoleacetic acid (IAA), indolepyruvic acid (IPA), indolebutyric acid (IBA), naphthaleneacetic acid (NAA), 2,4-dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), adenine, benzyladenine, kinetin, 6-( $\gamma$ , $\gamma$ -dimethylallylamino)-purine, tricanthine, zeatin, casein hydrolysate, coconut milk, and yeast extract individually and in different combinations. Twenty-four cultures were maintained under daylight (10-20 ft.-c), at  $25 \pm 2^\circ \text{C}$  and 50-60% relative humidity.

On WM, which served as the control, the embryo developed into a seedling and the endosperm collapsed in eight weeks after culture. On WM plus an auxin—IAA, IPA, IBA, NAA, 2,4-D, or 2,4,5-T—both embryo and endosperm proliferated (Fig. 1, B). The callus from embryo as well as from endosperm showed unlimited growth on WM supplemented with IBA (5 ppm). On WM enriched with 5 or 10 ppm of any one of the 6-substituted aminopurines, the embryo formed a seedling. In 80% of the cultures on WM + kinetin (5 ppm) or adenine (20 ppm) numerous

shoot buds appeared adventitiously from the radicular end of the embryo, 6-8 weeks after culture. The endosperm did not show any visible morphological change, except for a negligible proliferation; though the cultures were maintained for over 20 weeks.

Unlike auxin or cytokinin alone, a combination of the two with WM induced growth and differentiation of shoot buds both from embryo and endosperm. In 90% of the cultures additional shoot buds appeared from the radicular end of the embryo, whereas only 16% of the cultures showed shoots originating from endosperm. Addition of casein hydrolysate (2000 ppm) to WM + IAA (5 ppm) + kinetin (10 ppm) or adenine (40 ppm) enhanced the percentage of cultures forming shoot buds from embryo to 95 and from endosperm callus to 35. Embryo as well as endosperm callus, formed on WM + IBA (5 ppm), when transferred to WM + IAA + kinetin (or adenine) + casein hydrolysate differentiated shoot buds in 70 and 50% cultures, respectively. Several leaves (maximum length 2.5 cm.) were formed from these buds of endosperm origin, and were similar in shape to the plumular leaves (Fig. 1, C).

Anatomical studies revealed that the endosperm usually proliferated on the surface that lay in contact with the agar medium, and the shoot buds developed on the surface away from the medium (Fig. 1, D).

The basic chromosome number of *Dendrophthoe falcata* as determined from the aceto-carmine squashes of microspore mother cell is 9. The plumular shoots and their leaf-tip cells formed *in vitro* showed the diploid number 18. But the shoot and leaf-tips which developed from the endosperm or endosperm callus were, as expected, triploid ( $3n=27$ ; Fig. 1, E).

Thus, the endosperm of angiosperms, like any other tissue, retains all the genetic information and its totipotency can be evoked under suitable cultural conditions.

We are indebted to Dr. N. S. Rangaswamy and Dr. S. S. Bhojwani, for valuable suggestions, and to Mr. R. N. Bhat for assisting us in making suitable cytological preparations. Financial assistance of the University Grants

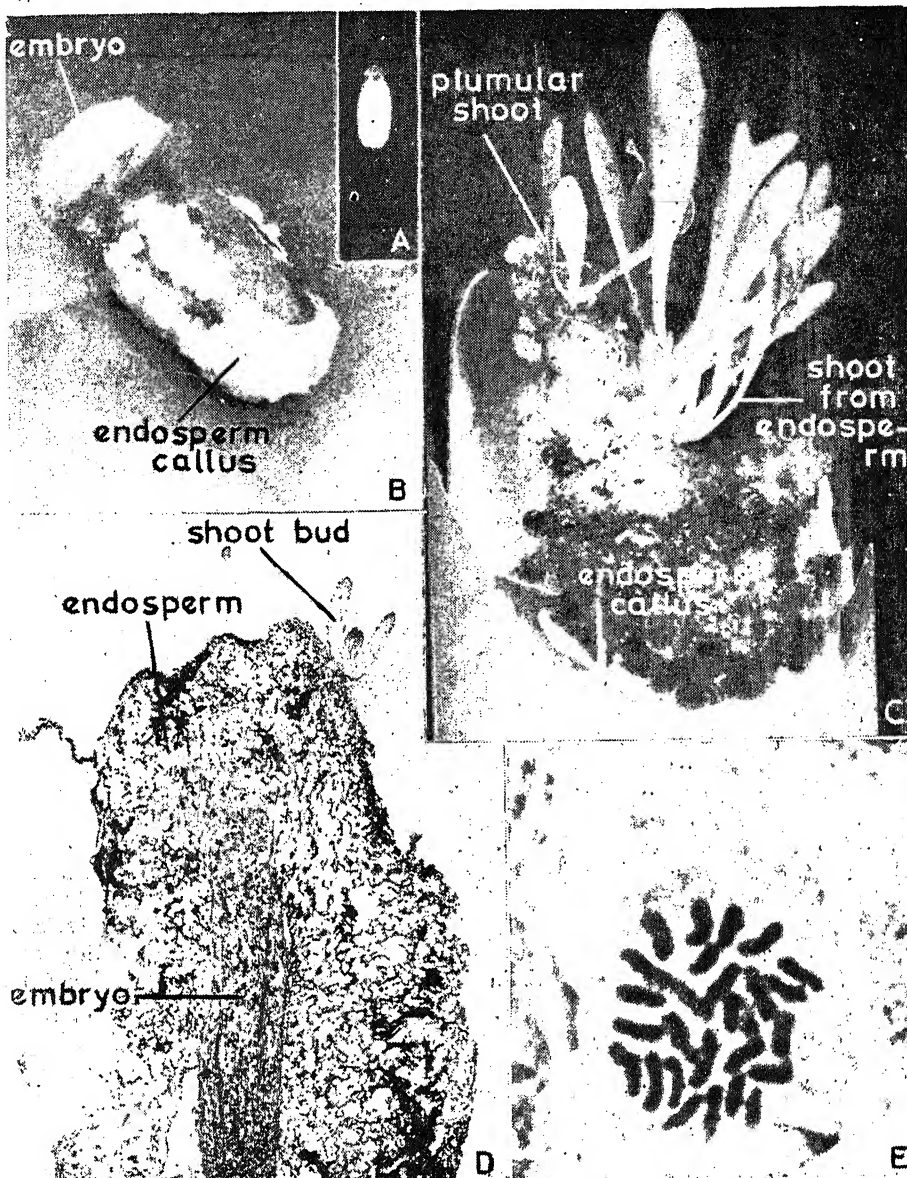


FIG. 1, A-E. Morphogenesis in endosperm cultures of *Dendrophthoe falcata*. A. Seed at culture,  $\times 1.5$ . B. 3-week-old culture on WM + IBA (20 ppm) showing proliferation of embryo and endosperm,  $\times 5$ . C. Same, 14-week-old, on WM + IAA (5 ppm) + kinetin (10 ppm) + casein hydrolysate (2000 ppm); in addition to plumular leaves, note the development of leaves, from callused endosperm,  $\times 2.4$ . D. L.s. portion of seed from a 9-week-old culture on WM + IAA (5 ppm) + adenine (40 ppm) + casein hydrolysate (2000 ppm); note superficial origin of bud from endosperm,  $\times 15.6$ . E. A cell from acetocarmine squash of shoot tip formed from endosperm, showing 27 chromosomes ( $3n = 27$ ),  $\times 2,439$ .

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1. Rangaswamy, N. S. and Rao, P. S., *Phytomorphology*, 1963, 13, 450.
2. Satsangi, Asha and Mohan Ram, H. V., *Ibid.*, 1965, 15, 26.
3. Bhojwani, S. S., *Ibid.*, 1966, 16, 349.
4. Johri, B. M. and Bhojwani, S. S., *Nature*, London, 1965, 208, 1345.

## LETTERS TO THE EDITOR

## NEW BAND SYSTEMS OF CoBr IN THE PHOTOGRAPHIC INFRARED

ACCORDING to the recent work of Rao and Rao<sup>1</sup> (1962) based on high dispersion spectrograms taken in the first order of a 21 ft. concave grating (2.54 Å/mm.), four discrete band systems were designated and attributed to the CoBr molecule. Each of the systems A, B and C consisting of single-headed bands was attributed to a transition in which  $\Delta\Omega = 0$  whereas the system D consisting of double-headed bands was attributed to a transition in which  $\Delta\Omega = \pm 1$  corresponding to case (c). The weaker systems reported earlier by Krishna Murty<sup>2</sup> (1952) in the region  $\lambda$  4700– $\lambda$  6000 Å were too weak to be photographed under high dispersion, however they reported some diffuse and ill-defined bands of CoBr in the photographic infrared region.

In the present experiments the spectrum of CoBr has been reinvestigated in emission in high frequency discharge from a 500 watt oscillator and photographed using the high dispersion of a 21 ft. concave grating (1.25 Å/m.). In addition to the visible systems of CoBr in the region  $\lambda$  4300– $\lambda$  6000 Å reported by early workers, the spectrum revealed the existence of two systems of bands designated as  $N_1$  and  $N_2$  in the photographic infrared region ( $\lambda$  7000– $\lambda$  7300 Å). Bands of system  $N_1$  are single-headed, while those of the system  $N_2$  are double-headed. In each of the two systems the two main sequences  $\Delta v = 0$  and  $\Delta v = +1$  are identified. The two intense  $\Delta v = 0$  sequences of the two systems are shown in Fig. 1. A feature of these systems is that while

wavelengths. The vibrational assignments of bands in the  $\Delta v = +1$  sequence in each of the systems has been confirmed from a study of the Bromine isotope effect. The vibrational constants of the two systems are given in Table I.

TABLE I

Vibrational constants of the upper and lower states of the  $N_1$  and  $N_2$  systems

System	$r_e$ cm. <sup>-1</sup>	$\omega_e$ cm. <sup>-1</sup>	$x_e \omega_e$ cm. <sup>-1</sup>	$\omega_e''$ cm. <sup>-1</sup>	$x_e'' \omega_e''$ cm. <sup>-1</sup>
$N_1$	13831.4	331.3	1.35	316.4	0.88
$N_2$	13740.5 <sup>q</sup>	332.2	1.40	313.9	0.50

Since terms of odd multiplicity are expected for the electronic states of CoBr, the close proximity of the two systems and the magnitude of the vibrational constants, seem to suggest that they may belong to two components of a  $3\pi-3\Sigma$  transition, as in the case of the analogous  $N_1$  and  $N_2$  systems of CoCl in the photographic infrared. As CoBr is heavier than CoCl, we may expect even a greater tendency towards case (c). Thus the  $N_1$  system consisting of single-headed bands, may be attributed to the case (c) equivalent of  $3\Pi_0-3\Sigma$  transition, and the  $N_2$  system consisting of double-headed bands to the case (c) equivalent of  $3\Pi_1-3\Sigma$  transition. Both the upper and lower states of the  $N_1$  and  $N_2$  systems of CoBr do not correspond to those previously identified from the analysis of the visible systems. They appear to belong to two different excited states

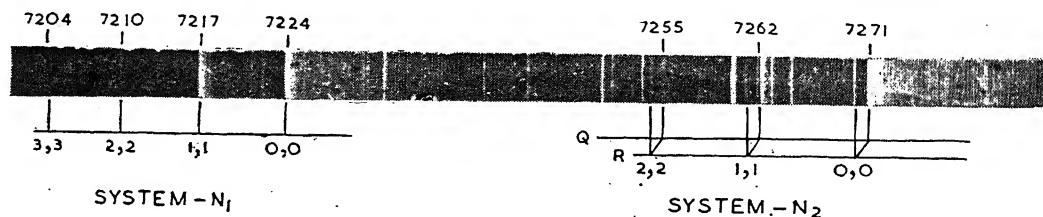


FIG. 1. (0, 0) Sequences of the  $N_1$  and  $N_2$  systems of CoBr.

the bands are degraded to longer wavelengths, the sequences are degraded towards shorter

of the CoBr molecule. A similar situation is also observed in the band systems of CoCl,

MnCl, MnF and MnBr in the photographic infrared.

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Andhra University,  
Waltair, August 7, 1968.

1. Rao, S. V. K. and Rao, P. T., *Ind. J. Phys.*, 1962, **36**, 609.
2. Krishna Murty, V. G., *Ibid.*, 1952, **26**, 177.

# INTEGRATED ABSORPTION INTENSITIES OF THE CARBONYL BAND IN DIMETHYL AND DIPHENYL BENZAMIDES

SPECTROSCOPIC studies of amides and their deuterated species in regard to the intermolecular associations and normal vibrational analysis received considerable attention in recent times in order to understand the strength of the H-bond interaction between the functional groups and the nature of the absorption bands.<sup>1-4</sup> In this note we report the intensity of the carbonyl band in N, N-dimethylbenzamide and N, N-diphenylbenzamide in solutions of CCl<sub>4</sub> calculated by both Ramsay's and Wilson-Wells methods.

Perkin Elmer Model 221 infrared spectrophotometer. A spectral slit width of 3.5 cm.<sup>-1</sup> was used in the region of the carbonyl band and gear combinations were so chosen as to spread the spectrum to 100 cm.<sup>-1</sup> = 10 cm.

The integrated absorption intensities are given in Tables I and II. The intensities obtained by the two methods agree fairly well. The intensity of the carbonyl band in dimethylbenzamide is higher than that in diphenylbenzamide. On the other hand, the frequency of the carbonyl band of dimethylbenzamide is less by 22 cm.<sup>-1</sup> than that of diphenylbenzamide.

The high polarity of the C=O bond in amides is due to the two possible resonance structures or because of the interaction of the  $\pi$ -orbitals of the C=O group and the lone pair orbitals of N atom formed from the P<sub>z</sub> atomic orbitals. The  $\pi$ -p interaction is responsible for the high values of integrated intensity of the carbonyl band in N, N-dimethylbenzamide, and the lower value of intensity of the carbonyl band in N, N-diphenylbenzamide is due to the weakening of this  $\pi$ -p interaction due to the competitive effect of the phenyl ring for the lone pair of electrons on the nitrogen atom. This reasoning

TABLE I

Integrated absorption intensities of the carbonyl band—Ramsay's method

Amide	Molar concentration	Frequency in cm. <sup>-1</sup>	Log (T <sub>0</sub> /T) <sub>max.</sub>	$\frac{S}{\Delta \nu_1^{(a)}}$	K	A in units of 10 <sup>4</sup>	Mean value of A
N, N-Dimethylbenzamide	•00525	1644	0.33	0.17	1.56	4.7	4.6
	•00466	1644	0.28	0.17	1.56	4.5	
N, N-Diphenylbenzamide	•0080	1666	0.50	0.18	1.55	4.2	4.15
	•0050	1666	0.33	0.20	1.55	4.1	

TABLE II

Integrated absorption intensities of the carbonyl band—Wilson-Wells method

Amide	Molar concentration	$2.303 \int \epsilon \cdot d\nu$	$\frac{\nu - \nu_m}{b}$	Wing correction	A in units of 10 <sup>4</sup>	Average of A
N, N-Dimethylbenzamide	•00525	4.23	5.8	0.52	4.8	4.75
	•00466	4.18	5.8	0.51	4.7	
N, N-Diphenylbenzamide	•0080	3.67	6.6	0.39	4.1	4.1
	•0050	3.72	7.1	0.36	4.1	

The spectra of the carbonyl band of these amides were recorded with matched cells of 1 mm. thickness with NaCl windows using

also explains the low frequency of the carbonyl band in dimethylbenzamide than in diphenylbenzamide.



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Univ. College of P. SYAMALA KRISHNA SAYEE.  
Science,  
Osmania University,  
Hyderabad-7, July 4, 1968.

1. Puranik, P. G. and Venkata Ramiah, K., *J. Mol. Spectroscopy*, 1959, **3**, 486; *Proc. Ind. Acad. Sci.*, 1961, **54**, 69.
2. Miyazawa, T., Shimanouchi, T. and Mizushima, S., *J. Chem. Phys.*, 1958, **29**, 611.
3. Suzuki, I., *Bull. Chem. Soc. Japan*, 1960, **33**, 1359; *Ibid.*, 1962, **35**, 1279; *Ibid.*, 1962, **56**, 115.
4. Jones, R. L., *J. Mol. Spectroscopy* 1963, **11**, 411.
5. Venkata Chalapathi, V. and Venkata Ramiah, K., *Proc. International Conference on Spectroscopy*, 1967, **2**, 318; *J. Mol. Spectroscopy* (Under publication).

### X-RAY AND ELECTRONMICROSCOPIC STUDIES OF SOLID SOLUTIONS OF CALCIUM AND STRONTIUM HYDROXYLAPATITES

CALCIUM hydroxylapatite,  $3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{Ca}(\text{OH})_2$  (abbreviated as CaHA), the inorganic constituent of animal bones and teeth, undergoes several ion exchange reactions. The most important among them is  $\text{Ca}^{2+} \rightleftharpoons \text{Sr}^{2+}$  substitution which explains the mechanism of incorporation of  $\beta$ -active  $\text{Sr}^{90}$  produced in atomic explosions, into the skeletal system.<sup>1</sup> Solid solutions of CaHA and its isomorphous substance Strontium hydroxylapatite (abbreviated as SrHA) were prepared earlier by thermal diffusion<sup>2</sup> and co-precipitation<sup>1,3</sup> techniques. The present work is to investigate the utility of X-ray diffraction and electronmicroscopy to confirm the formation and homogeneity of these solid solutions prepared by Collin's method.<sup>1</sup>

The quantitative separation of calcium, strontium and phosphate in the solid solutions was brought about by a method<sup>4</sup> specially worked out by us for the purpose and for the subsequent chemical analyses standard gravimetric methods<sup>5,6</sup> were used. The X-ray diffraction patterns of the samples were taken using  $\text{CuK}_\alpha$  radiation and a Debye-Scherrer camera of 9 cm. diameter. The electronmicrographs were obtained using Siemens Elmiskop I, No. 591 with water as dispersion medium and carbon as background.

The molecular formulæ of the solid solutions which give the proportions of CaHA and SrHA were calculated from the results of chemical analyses and are given in Table I. The dilation of the unit cell volume of the apatite lattice with increase in the proportion of SrHA as is to be anticipated from the ionic radii of  $\text{Ca}^{2+}$  (0.99 Å) and  $\text{Sr}^{2+}$  (1.13 Å) is indicated by the lattice constants of the samples (Table I).

Representative electronmicrographs of a few of the samples (Fig. 1) show needle-shaped crystals<sup>3</sup> characteristic of apatites and thus indicate the absence of extraneous phases and provide an idea of geometry of the individual crystals. The average length and breadth of crystals of CaHA were found to be  $\sim 530$  Å and  $\sim 170$  Å respectively and the corresponding values of SrHA being  $\sim 1728$  Å and  $\sim 224$  Å. The average dimensions of the intermediate samples were found to range between those of the end members. The increase in the crystal size of the solid solutions with the proportion of SrHA is in agreement with the dilation of the crystal lattice indicated by X-ray investi-

TABLE I  
Chemical and X-ray analyses of CaHA, SrHA and their solid solutions

Sample No.	wt. %			Molecular formula	g. atom ratio. (Ca+Sr)/P	Lattice constants (Å)	
	Ca	Sr	P			a	c
1	39.19	..	17.37	$\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$	1.63	9.420	6.950
2	34.92	3.1	17.81	$\text{Ca}_{9.6}\text{Sr}_{0.4}(\text{PO}_4)_6(\text{OH})_2$	1.58	9.425	6.882
3	32.66	10.24	17.91	$\text{Ca}_{8.75}\text{Sr}_{1.25}(\text{PO}_4)_6(\text{OH})_2$	1.57	9.445	7.171
4	22.48	21.50	16.26	$\text{Ca}_{7.2}\text{Sr}_{2.8}(\text{PO}_4)_6(\text{OH})_2$	1.50	9.482	7.260
5	18.52	31.55	13.73	$\text{Ca}_{5.6}\text{Sr}_{4.4}(\text{PO}_4)_6(\text{OH})_2$	1.57	9.566	7.450
6	16.00	35.10	16.61	$\text{Ca}_5\text{Sr}_5(\text{PO}_4)_6(\text{OH})_2$	1.53	9.616	7.300
7	12.76	43.70	14.15	$\text{Ca}_{3.9}\text{Sr}_{6.1}(\text{PO}_4)_6(\text{OH})_2$	1.79	9.685	7.400
8	9.16	45.23	15.15	$\text{Ca}_{2.1}\text{Sr}_{6.9}(\text{PO}_4)_6(\text{OH})_2$	1.52	9.995	7.400
9	4.89	52.04	13.05	$\text{Ca}_{1.7}\text{Sr}_{8.3}(\text{PO}_4)_6(\text{OH})_2$	1.70	10.160	7.570
10	..	58.48	12.62	$\text{Sr}_{10}(\text{PO}_4)_6(\text{OH})_2$	1.65	10.260	7.940



gations and thus the formation and homogeneity of the solid solutions are confirmed.



FIG. 1. A, B and C are electronmicrographs of samples 1, 7 and 10 respectively of Table I. (Magnification, 40,000 $\times$ .)

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Dept. of Chemistry, N. S. CHICKERUR.  
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September 1, 1968.

1. Collin, R. L., *J. Am. Chem. Soc.*, 1959, **81**, 5275.
2. Lagergren, C. and Carlstrom, D., *Acta Chem. Scand.*, 1957, **11**, 545.
3. Hayek, E. and Petter, H., *Monatsch.*, 1960, **91**, 356.
4. Chickerur, N. S. and Narasaraaju, T. S. B., *Analyst*, 1968, **93**, 344.
5. Washburn, M. L. and Shear, M. J., *J. Biol. Chem.*, 1932-33, **21**, 99.
6. Wagner, W., Hull, C. J. and Markle, G. E., *Advanced Analytical Chemistry*, Reinhold Publishing Corporation, N.Y., 1956, p. 133.

#### CONDENSATION OF N, N'-DIBENZYL-o-PHENYLENEDIAMINE WITH ACETONYLACETONE

CONDENSATION of o-phenylenediamine with acetonylacetone was found to yield 1-(2-amino-phenyl)-2,5-dimethyl pyrrole<sup>1</sup> or (1,1'-o-phenylene bis 2,5-dimethyl pyrrole)<sup>2</sup> depending upon the reaction conditions. Since the reaction between a primary amino group and a 1,4-diketone appears to facilitate exclusively the pyrrole ring formation, the reaction between N,N'-dibenzyl-o-phenylenediamine,<sup>3,4</sup> a dissecondary diamine, and acetonylacetone has been studied in the present investigation, with the hope of obtaining diazaheterocycles.

Since acetonylacetone, in reaction with amines, invariably reacts in the dienolic form, it is expected that an eight-membered ring-structure (I, C<sub>26</sub>H<sub>20</sub>N<sub>2</sub>) may result from the condensation of the diamine and diketone in 1:1 proportion.

The reaction when carried out in equimolecular proportion in acetic acid at room temperature yielded a crystalline compound, m.p. 230-31° C. in modest yields. The absence of a carbonyl group (no absorption between 1750-1680 cm.<sup>-1</sup>) and of a -NH or -OH function (no absorption at 3700 to 3600 cm.<sup>-1</sup>) in the compound is evident from its I.R. spectrum. The NMR spectrum of the compound in CDCl<sub>3</sub>, surprisingly enough revealed the presence of 46 protons in the molecule. Further, the presence of four phenyl groups, two diortho-substituted phenylene moieties and two methyl groups in the molecule is also indicated by

the NMR data (Table I). Thus it is evident that the product is formed from two moles of the diamine and one mole of the diketone. Based on this data, the compound has been assigned a 1,2-bis[2'-(1',3'-dibenzyl-2'-methyl)benzimidazolyl] ethane structure (II) (Found: N : 8.77% ; calculated for  $C_{46}H_{46}N_4$ , N : 8.56%).

It is interesting to note that acetylacetone reacted solely in the diketonic form in this condensation.

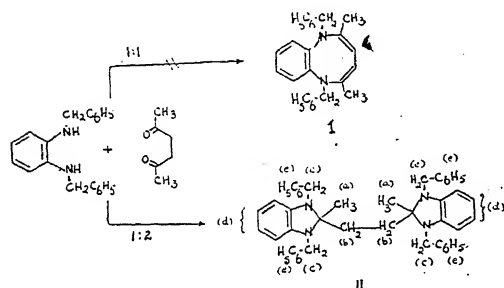


TABLE I  
NMR data

$\delta$	Integrated for	Assignment
1.22	6H	Two methyls (a)
2.05	4H	Two methylenes (b)
3.97	8H	Four methylenes (c)
6.20	8H	Two diorthosubstituted phenylenes (d)
7.23	10H	Four phenyls (e)

This appears to be the first instance when a benzimidazoline derivative is obtained from a  $N^1, N^2$ -disubstituted-o-diamine and a ketone.

The authors are grateful to Prof. N. V. Subba Rao for helpful discussions and to Dr. G. S. Sidhu, Director, Regional Research Laboratory, Hyderabad, for the NMR spectrum. One of the authors (KSR) is grateful to the University Grants Commission for the award of a Junior Research Fellowship.

Dept. of Chemistry, K. SUDARSANA RAO.  
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1. Subba Rao, N. V., Sudarsana Rao, K. and Ratnam, C. V., *Curr. Sci.*, 1965, 34 (13), 403.
2. Buu-Hoi, Ng. Ph. and Xuong, Ng. D., *J. Org. Chem.*, 1955, 20, 851.
3. Fischer, O. and Veiel, O., *Ber.*, 1905, 38, 323.
4. Veera Nagaiah, V., Ratnam, C. V. and Subba Rao, N. V. (Paper in press).

## A COMPARISON OF THE RATES OF OXIDATION OF CYCLOPENTANOL AND EXO-NORBORNEOL

DURING the course of our investigations on the effect of ring size on the chromic acid and bromine oxidation of secondary alcohols, we have had occasion to use cyclopentanol and exo-norborneol as the substrates. We expected that the effect of bridging cyclopentanol with a two-carbon bridge to form exo-norborneol (bicyclo [2-2-1] heptan-2-ol) would be to provide a driving force for rehybridization of  $C_2$  from  $sp^3$  to  $sp^2$  and hence might result in a faster rate of oxidation of the latter compound. But curiously enough, we find that, consistently under all conditions, cyclopentanol is oxidised at a faster rate than exo-norborneol both with chromic acid (about 3 times) and with bromine (about 10 times) (Table I).

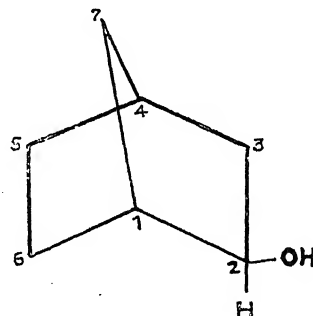


TABLE I

Second order constants ( $k_2$  in litre-mol<sup>-1</sup> sec.<sup>-1</sup>) for the oxidation of cyclopentanol and exo-norborneol in 70% HOAc-H<sub>2</sub>O

Alcohol	Br <sub>2</sub> oxidation ( $k_2 \times 10^2$ )		CrO <sub>3</sub> oxidation ( $k_2 \times 10^4$ )	
	40°	45°	45°	50°
Cyclopentanol	2.117	3.267	6.760	8.650
exo-Norborneol	0.252	0.366	1.315	3.094

While the large variation in the magnitude with the two oxidising agents is certainly due to the difference in the transition state geometries of chromic acid and bromine oxidations,<sup>1,2</sup> the common point that emerges is the slower oxidation of exo-norborneol with either oxidant.

We interpret our findings as follows. A consequence of connecting  $C_1$  and  $C_4$  of cyclopentane (or cyclopentanol) by a two-carbon bridge is that the ten eclipsed interactions in planar cyclopentane (or cyclopentanol) are

reduced to only four such corresponding interactions in norbornane (or in exo-norborneol).<sup>3</sup> The elimination of six of these interactions is achieved at the expense of an increased total angle strain largely centred in the C<sub>1</sub>, C<sub>7</sub>, C<sub>4</sub> angle of 96.32°. The increase in angle strain resisting a rehybridization around C<sub>2</sub> should be considerable for both the alcohols, but this is apparently identical in the two systems as evidenced by the virtual equality of the carbonyl stretching frequencies of cyclopentanone (1750 cm.<sup>-1</sup>)<sup>5</sup> and norbornane-2-one (1751 cm.<sup>-1</sup>).<sup>6</sup> The two-carbon bridge further accentuates the puckering effect exercised by the cyclopentane molecule itself in order to reduce its energetically costly torsional interactions. A rehybridization of C<sub>2</sub> of norborneol from sp<sup>3</sup> to sp<sup>2</sup> will relieve only two such eclipsed torsional interactions while the same transformation in cyclopentanol will entail the relief of four such interactions. This would then, in our opinion, account for the slower oxidation rate of exo-norborneol over that of cyclopentanol.

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July 24, 1968.

1. Srinivasan, G. and Venkatasubramanian, N., *Proc. Ind. Acad. Sci.*, 1967, **65**, 30.
2. Thiagarajan, V. and Venkatasubramanian, N., *Ibid.*, 1968, **67**, 37.
3. Eliel, E. L., *Stereochemistry of Carbon Compounds*, McGraw-Hill Book Co., N.Y., 1962, p. 302.
4. Sargent, G. D., *Quart. Revs.*, 1966, **20**, 323.
5. Zbinden, R. and Hall, H. K., *J. Am. Chem. Soc.*, 1960, **82**, 1215.
6. Angell, C. L. et al., *Spectrochim. Acta*, 1959, **15**, 926.

#### RELATIONSHIP OF HEXOKINASE TO PYRIDOXINE DEFICIENCY IN *ASPERGILLUS NIDULANS*\*

HEXOKINASE activity has been demonstrated in extracts of *Streptococcus faecalis*,<sup>1</sup> *Clostridium butyricum*<sup>2</sup> and *Neurospora crassa*.<sup>3</sup> Kanakasabapathi and Shanmugasundaram<sup>4</sup> assayed the activity of hexokinase in a number of riboflavineless mutants of *A. nidulans*, in their attempts to study the electron transport pathways in riboflavineless mutants of *A. nidulans*.

The present note deals with the hexokinase activity in pyridoxine-deficient mutants with white and yellow spore colours and the corresponding yellow and white prototrophs of

*A. nidulans*. The study was made with a view to understand the effect of pyridoxine deficiency on hexokinase in *A. nidulans*.

The yellow pyridoxineless mutant *y*; *pyro4*, was originally isolated at the Genetics Department, University of Glasgow. A white pyridoxineless mutant *w6*; *pyro4* was produced by ultra-violet irradiation of *y*; *pyro4*, and its genetic analysis was worked out.<sup>5</sup> *w6*; *pyro4* is allelic to *y*; *pyro4* only in pyridoxine requirement and is non-allelic with respect to the white spore colour. The white and yellow prototrophs were obtained as recombinants from a cross.

The yellow and white prototrophs of *A. nidulans* were grown in 2 litres of minimal medium according to Pontecorvo<sup>6</sup> in Haffkine's flasks. The pyridoxine-deficient mutants *w6*; *pyro4* and *y*; *pyro4* were grown in 2 litres of minimal medium supplemented with pyridoxine.

The media were sterilised at 10 lb. pressure for 15 minutes, cooled and inoculated with the spores of the respective strains. The flasks were incubated at 30° C. (lab. temp.). On the 7th day, the mycelia were harvested, washed with distilled water repeatedly, and dried between folds of filter-paper.

The mycelia were macerated, in Potter-Elvehjem homogeniser<sup>7</sup> provided with a teflon pestle, with water to form a 20% homogenate and centrifuged at 3000 r.p.m. for 15 minutes, at 0° C. The supernatant was used as the enzyme source of hexokinase. The protein content of the enzyme was determined by the method of Lowry et al.<sup>8</sup>

The method adopted for the assay of hexokinase activity was essentially the same as that used by McDonald.<sup>9</sup> However, slight modifications were made. The test-tube containing the reaction mixture, prepared according to McDonald was cooled at 5° C., in a cold room maintained at 3°-6° C. and to it was added 1.0 ml. of the ice-cold hexokinase solution. The mixture was titrated immediately with 0.01 M NaOH or HCl from a microburette to the colour of the standard. The adjusted mixture was left at 5° C. for one hour, and then retitrated with 0.01 M NaOH to the colour of the standard.

One unit of hexokinase is taken as the amount of enzyme which catalyses the formation of  $1 \times 10^{-8}$  acid equivalent per hour at 5° C. and pH 7.5 in the standard reaction mixture. Specific activity is expressed as

hexokinase units per mg. of protein. The results are presented in Table I.

TABLE I

The hexokinase activity of the strains yellow wild, white wild and the pyridoxineless auxotrophs, *y*; *pyro4* and *w6*; *pyro4*.

The specific activity is expressed as units/mg. wt. of protein/hr.

Name of the strain	Specific activity	% of activity as compared to yellow prototroph
Yellow prototroph ..	118.2	100
White prototroph ..	110.76	94
<i>y</i> ; <i>pyro4</i> ..	63.06	53
<i>w6</i> ; <i>pyro4</i> ..	65.10	55

It is seen from Table I, that the yellow and white prototrophs have almost double the activity of hexokinase as that exhibited by the pyridoxine-deficient mutants.

It is significant that the two prototrophs which differ in their conidial colour have almost the same amount of hexokinase activity, while the auxotrophs *y*; *pyro4* and *w6*; *pyro4* which also differ only in their conidial colour have very nearly the same hexokinase activity. These observations indicate that hexokinase activity is closely associated with pyridoxine deficiency, irrespective of the conidial colour.

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1. Sokatch, J. T. and Gunsalus, I. C., *Bact. Proc.*, 1954, 109, 110.
2. Govard, R., *C.R. Acad. Sci. Paris*, 1954, 238, 1620.
3. Antonia Medina and Nicholas, D. J. D., *Biochem. J.*, 1957, 66, 573.
4. Kanakasabapathi, A. S. and Shanmugasundaram, E. R. B., *Encyclopedia*, 1966, 30, 81.
5. Jana Bai, R., *Ph.D. Thesis*, University of Madras, 1966.
6. Pontecorvo, G., *Adv. Genetics*, 1955, 5, 150.
7. Potter, V. K. and Elvehjem, C. A., *J. biol. Chem.*, 1936, 114, 495.
8. Lowry, O. H., Rosbrough, N. J., Lewis Farr, A. and Randall, R. J., *Ibid.*, 1951, 193, 265.
9. McDonald R. Margaret. *Methods in Enzymology*, 1962, 1, 269.

## DERIVATIVES OF 5-SUBSTITUTED FURFURALDEHYDES

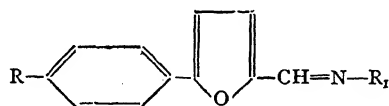
A VARIETY of 5-nitrofurfuraldehyde derivatives have been reported<sup>1-7</sup> to possess antibacterial and antifungal properties. During the course of our work on nitrofurfuraldehyde derivatives (unpublished work), we thought it would be of interest to study the pharmacological properties of furfuraldehyde derivatives with electron-withdrawing groups in position 5, simulating the situation in 5-nitrofurfuraldehyde. We chose 5-(*p*-sulphamylphenyl)- and 5-(*p*-carbethoxyphenyl)-furfuraldehyde for our study, and their derivatives are listed in Table I.

The choice of the aldehydes was prompted because of the available information<sup>8-10</sup> on introducing aryl substituents in position 5 of furfuraldehyde, and the muscle relaxant properties reported<sup>10</sup> for 5-(*p*-nitrophenyl)-furfurylidene *N*-aminohydantoin.

5-(*p*-sulphamylphenyl)-furfuraldehyde and 5-(*p*-carbethoxyphenyl) furfuraldehyde were prepared by coupling respectively *p*-sulphamylphenyldiazonium chloride and *p*-carbethoxyphenyldiazonium chloride with furfuraldehyde in aqueous acetone with cupric chloride as catalyst. The aldehydes were condensed with amino compounds in acetic acid or dimethylformamide to obtain the corresponding aldimine derivatives. The pharmacological data on these compounds will be a matter for subsequent communication.

5-(*p*-Sulphamylphenyl)-Furfuraldehyde.—*p*-Aminobenzenesulphonamide (17 g.; 0.1 mole) was dissolved in dilute hydrochloric acid (0.3 mole; 50 ml. water). The solution was stirred and cooled to  $-5^{\circ}$ . To it was added sodium nitrite (7 g.; 0.1 mole) in water (40 ml.) over 10 minutes. The diazonium salt solution was kept stirred for an additional 20 minutes. A solution of freshly distilled furfuraldehyde (9.6 g.; 0.1 mole) in acetone (30 ml.) was then added over 10 minutes keeping the reaction solution at  $0^{\circ}$ . After 10 minutes of additional stirring, a solution of copper chloride (2 g.; 30 ml.) was added. The reaction solution was allowed to come to room temperature over 4 hours. The reaction was then allowed to stand overnight. The yellow solid thus obtained (9.5 g.) was filtered and crystallised from dilute acetic acid; m.p.  $188-90^{\circ}$ . Found: N, 5.79; Calc. for  $C_{11}H_9NO_4S$ ; N, 5.58%.

TABLE 1



No.	R	R <sub>1</sub>	m.p. °C.*	Nitrogen %	
				Found	Calc.
I	SO <sub>2</sub> NH <sub>2</sub>	4-Chlorophenyl	211-13	8.10	7.77
II	SO <sub>2</sub> NH <sub>2</sub>	2-Methyl-4-chlorophenyl	193-95	7.36	7.48
III	SO <sub>2</sub> NH <sub>2</sub>	4-Sulphamylphenyl	236-38	10.54	10.37
IV	SO <sub>2</sub> NH <sub>2</sub>	3, 4-Dichlorophenyl	174-76	6.83	7.09
V	SO <sub>2</sub> NH <sub>2</sub>	2, 3-Dichlorophenyl	173-75	7.13	7.09
VI	SO <sub>2</sub> NH <sub>2</sub>	4-Nitrophenyl	137	10.95	11.32
VII	SO <sub>2</sub> NH <sub>2</sub>	2, 3, 4, 5-Tetrahydro-2, 4-dioxo-3-imidazolyl	279	16.34	16.09
VIII	SO <sub>2</sub> NH <sub>2</sub>	Hexamethyleneimino	175-76	12.02	12.11
IX	SO <sub>2</sub> NH <sub>2</sub>	Amino	170-72†	16.13	15.85
X	SO <sub>2</sub> NH <sub>2</sub>	2H-benzisothiazol-1, 1-dioxide-3-imino	313 (d)	13.34	13.02
XI	COOC <sub>2</sub> H <sub>5</sub>	4-Sulphamylphenyl	207-09	7.15	7.04
XII	COOC <sub>2</sub> H <sub>5</sub>	3, 4-Dichlorophenyl	84-86	3.54	3.61
XIII	COOC <sub>2</sub> H <sub>5</sub>	Amino	128-30	11.18	10.85
XIV	COOC <sub>2</sub> H <sub>5</sub>	Hexamethyleneimino	105-06	8.49	8.24
XV	COOC <sub>2</sub> H <sub>5</sub>	2, 3, 4, 5-Tetrahydro-2, 4-dioxo-3-imidazolyl	244-46	12.17	12.31
XVI	COOC <sub>2</sub> H <sub>5</sub>	2H-benzisothiazol-1, 1-dioxide-3-imino	258-60 (d)	10.10	9.93

\* All melting points are uncorrected. † The product solidifies immediately and sinters above 275°.

5-(p-carbethoxyphenyl)-furfuraldehyde was similarly prepared and it melted at 106-08°.

Found: N, 16.34; Calc. for C<sub>14</sub>H<sub>12</sub>N<sub>4</sub>O<sub>5</sub>S: N, 16.09%.

3-(p-sulphamylphenyl)-Furfurylidene sulph-anilamide.—A solution of p-aminobenzenesulphonamide (1.7 g.; 0.01 mole) in acetic acid (10 ml.) was added to a solution of 5-(p-sulphamylphenyl)-furfuraldehyde (2.5 g.) in dimethylformamide (15 ml.) at 60° C. After 10 minutes, the reaction solution was diluted with water (10 ml.), cooled and filtered. The yellow solid (3.2 g.) was crystallised from acetic acid; m.p. 236-38°. Found: N, 10.54; Calc. for C<sub>17</sub>H<sub>15</sub>N<sub>3</sub>O<sub>5</sub>S<sub>2</sub>: N, 10.37%.

5-(p-Carbethoxyphenyl)-Furfurylidene Sulph-anilamide.—A solution of 5-(p-carbethoxyphenyl)-furfuraldehyde (2.4 g.; 0.01 mole) in acetic acid (10 ml.) at 60° was added to a solution of p-aminobenzenesulphonamide (1.7 g.; 0.01 mole) in acetic acid (10 ml.). After 10 minutes the reaction mixture was diluted with water (20 ml.) and filtered. The precipitate (3.5 g.) was crystallised from dilute acetic acid; m.p. 207-09°. Found: N, 7.15; Calc. for C<sub>20</sub>H<sub>18</sub>N<sub>2</sub>O<sub>5</sub>S: N, 7.04%.

5-(p-sulphamylphenyl)-Furfurylidene N-aminohydantoin.—A solution of 5-(p-sulphamylphenyl)-furfuraldehyde (2.5 g.) in dimethylformamide (15 ml.) was added to a solution of aminohydantoin hydrochloride (0.02 mole) in water (100 ml.) at 60°. The reaction mixture was allowed to stand overnight. The solid (4 g.) was filtered off and crystallised from aqueous dimethylformamide; m.p. 279°.

5-(p-Carbethoxyphenyl)-Furfurylidene 3-Hydrazone-2H-Benzisothiazol-1, 1-Dioxide.—To a solution of 5-(p-carbethoxyphenyl)-furfuraldehyde (2.4 g.; 0.01 mole) in acetic acid (10 ml.) at 60° was added a solution of 3-hydrazone-2H-benzisothiazol-1, 1-dioxide (1.9 g.; 0.01 mole) in dimethylformamide (15 ml.). The reaction solution was cooled after 10 minutes and filtered. The product

(3.1 g.) was crystallised from aqueous dimethylformamide; m.p. 258–60° (d). Found: N, 10.10; Calc. for  $C_{21}H_{17}N_3O_3S$ : N, 9.93%.

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1. Eisai, Co., Ltd. (by Toyoshima, S. and Shimada, K.). Japan, 25,056 (C.A., 1966, 64, S136<sup>a</sup>).
2. J. R. Geigy A.-G. (by Hook, W. H. and Hoyle, W.). Brit., 1,035,771 (C.A., 1966, 65, 16987<sup>e</sup>).
3. Norwich Pharmacol Co., *Neth. Appl.*, 6, 601,928 (C.A., 1967, 66, 7132).
4. Saikachi, H. and Shimamura, S., *Yakagaku Zasshi*, 1960, 80, 37 (C.A., 1960 54, 13092<sup>f</sup>).
5. Sasaki, T., *Pharm. Bull. (Japan)*, 1954, 2, 123 (C.A., 1956, 50, 971<sup>f</sup>).
6. Zawadowska, I., *Wiss. Z. Ernst Moritz Arnot. Univ. Mat Nat. Wiss.*, 1962, 11, 335 (C.A., 1965, 63, 15253<sup>d</sup>).
7. Koschucharov, P. and Harisanova, T., *Pharmazie*, 1960, 15, 492 (C.A., 1962, 56, 11712<sup>f</sup>).
8. Akashi, H. and Oda, K., *Rept. Inst. Chem. Res. Kyoto Univ.*, 1949, 19, 93 (C.A., 1951, 45, 7519<sup>h</sup>).
9. Davis, C. S. and Loughheed, G. S., *J. Heterocyclic Chem.*, 1967, 4, 153.
10. Snyder, H. R., Davis, C. S., Bicketon, R. K. and Halliday, R. P., *J. Med. Chem.*, 1967, 10, 807.

#### A NOTE ON THE DISTRIBUTION OF VARIOUS TYPES OF FOOT-AND- MOUTH DISEASE VIRUS IN UTTAR PRADESH

FOOT-AND-MOUTH disease (FMD) of cattle and other cloven footed animals occurs in an endemic form in India. Every year, this country suffers an economic loss of about 400 million rupees due to this disease (Dhanda and Gopal Krishan, 1958). To evolve a suitable FMD vaccine the knowledge of the distribution of various types of FMD virus is essential.

The limited information available so far indicates that FMDV types O, A, C, and Asia<sub>1</sub> occur in this country. Dutta (1951) reported the occurrence of 37 strains of type O or O variants, 17 strains of type A or A variants, 7 strains of type C or C variants and one strain of atypical nature from a total of 62 strains typed at Indian Veterinary Research Institute. During the next few years, the number of such strains increased to 74 which comprised of 43 strains of type O or O variants, 27 strains of A or A variants, 7 strains of C or C variants and 3 strains of Asia<sub>1</sub> (Dhanda and Gopal Krishan, 1958). Khara and Dhillon (1963) typed four strains from Punjab, three of which were serologically related to type O and the fourth one to Asia<sub>1</sub>.

Since then there seems to be no other published report on FMDV types from this country except the scattered information available from I.V.R.I. annual reports which revealed the typing of 36 strains of O or O variants, 10 strains of A or A variants, 3 strains of C or C variants and 14 strains of Asia<sub>1</sub> during the years 1958–59 to 1965–66. The purpose of the present note is to report the results of the typing of FMD virus from the specimens received in this Department during the years 1965–66 and 1966–67 from different parts of U.P.

A total of 84 specimens usually from mouth lesions were either received from field by post in glycerine saline or were collected fresh and typed immediately by complement fixation test following the technique of Brooksby (1952). In few cases, the material was first passaged in 5 to 7 days old suckling mice before typing by complement fixation test. Among the specimens found suitable for typing, viral antigen was revealed in only 24 specimens. Thirteen of these were serologically related to FMDV type O, 8 to type A and 3 to Asia<sub>1</sub>. The source of all the O and A types was bovines and those of Asia<sub>1</sub> an outbreak in pigs.

The results presented in the note indicate the predominance of FMDV type O followed by type A and Asia<sub>1</sub> respectively. None of the specimens tested in the present investigation revealed the presence of FMDV type C. In general these results are comparable to those reported earlier from I.V.R.I.

The authors are grateful to Major C. V. G. Choudary, Principal, for providing the facilities to carry out the work.

Department of Bacteriology, P. P. SINGH.  
U.P. College of Veterinary M. P. BANSAL.  
Science and Animal B. S. MALIK.  
Husbandry,  
Mathura, July 20, 1968.

1. Brooksby, J. B., *The Technique of Complement Fixation in Foot-and-mouth Disease. Research A.R.C. Report Series No. 12*, 1952.
2. Dhanda, M. R. and Gopal Krishan, V. R., *Foot-and-mouth Disease in India, I.C.A.R. Research Series No. 16*, 1958.
3. Dutta, S., *I.V.J.*, 1951, 27, 403.
4. *Indian Veterinary Research Institute, Annual Reports for the Years 1958–59 to 1965–66*.
5. Khara, K. S. and Dhillon, S. S., *Amer. J. Vet. Res.*, 1963, 24, 187.

# HORMONE-LIKE ACTION OF THE STEROL FRACTION FROM THE NERVOUS TISSUE OF COLD AND WARM ACCLIMATED EARTHWORM, *LAMPITO MAURITII*

EARLIER studies of Rao and his co-workers<sup>1-4</sup> on the effect of the body fluids of 'cold and warm' acclimated worms on the oxygen consumption of the tissues of normal, cold and warm acclimated worms showed that the body fluids from 'cold' acclimated worms enhanced, while those from 'warm' acclimated worms depressed tissue respiration. Similar effects were noticed in the scorpion, *Heterometrus fulvipes* by Vijayalakshmi.<sup>5</sup> These effects of nervous tissue extracts and body fluids were later confirmed by Precht<sup>6</sup> and his co-workers.

However, the nature of the active substance in these extracts has not been established, although Vijayalakshmi<sup>5</sup> showed that the effect persists even after heating the extract to 60° C. In the present investigation it was therefore considered fruitful to carry this part of the analysis a step further by extracting the non-saponifiable sterol fraction of the nervous tissue extract. The sterol fraction thus obtained from the nervous tissue of cold and warm acclimated worms is studied for its effect on tissue respiration of normal worms.

Earthworms (*Lampito mauritii*) were acclimated to cold (20° C.), warm (35° C.) and normal (28 ± 1° C.) temperatures for more than 15 days. The sterol fraction from the nervous-tissue of acclimated worms was procured by saponifying the tissue with alcoholic potassium hydroxide (2.5% in 95% ethanol) and the non-saponifiable sterol fraction was extracted with 95% alcohol. 0.1 ml. of this extract containing the active principles from about 0.1 mg. of nervous tissue was added to the tissue *in vitro* as described below.

The tissue respiration was studied by Warburg's manometric technique as described by Umbreit *et al.*<sup>7</sup> under the conditions described by Saroja and Rao.<sup>3</sup> To study the effect of the above extract on the respiration of normal tissues, 0.1 ml. of cold or warm extract as the case may be was taken in the side-arm of the experimental flask with 0.9 ml. of the Ringer. 2 ml. of the Ringer including the tissue was taken in the main chamber. Side by side, a control flask is prepared which differed from the experimental flask only in

receiving 0.1 ml. of the normal extract in the side-arm instead of cold or warm extract.

From the data presented in Table I it is evident that the tissue respiration is higher in the 'cold' extract-treated set than in the controls. An opposite trend is seen in the warm extract-treated set. The per cent increase in relation to controls in cold extract-treated set is + 68.9 and the per cent decrease in relation to normal in warm extract-treated set is - 21.23. The levels of significance between 28° C. and 20° C. and that between 28° C. and 35° C. are 7.237 and 1.741 respectively and the data are significant at 1% and 10% levels respectively.

TABLE I

Effect of sterol fraction of the acclimated nervous tissue on the tissue respiration of normal worms

Nature of the extract used	Number of observations	Microlitres of oxygen/gram/hour	't' level of significance
'Cold' extract-treated tissue	11	308 ± 101.54*	7.237
Normal extract-treated tissue (controls)	9	178.5 ± 46.40*	
Warm extract treated tissue	8	140.3 ± 38.6*	1.741

\* Mean ± S.D.

The change in the respiration of the tissues produced by the sterol fraction of the nervous tissue of 'cold' and 'warm' acclimated worms clearly indicated the presence of one or more hormone-like factors which can produce *in vitro* effects. Generally, cold acclimation results in the increased metabolic rate of the tissues while warm acclimation decelerates the same.<sup>4</sup> Thus it can be presumed from this study that a neurohormonal factor which activates or retards the metabolic rate of the tissues may be present in the sterol fraction of the CNS of cold and warm acclimated worms respectively. The fact that this extract of 'cold' acclimated worms is capable of raising the metabolic rate of 'normal' tissues, and the warm extract, of depressing the metabolic rate of the tissues of 'normal' worms, clearly suggests the presence of an activating factor in the sterol extract from the nervous tissue of cold acclimated worms and a substance with a decelerating effect in the sterol extract from the nervous tissue of warm worms.

[illegible][illegible]

1. The first step in the process of identifying a potential threat is to determine the source of the information. This can be done by reviewing the information received and identifying the person or organization that provided it. Once the source has been identified, the next step is to assess the credibility of the information. This can be done by checking the source's track record and the reliability of the information provided. If the information is deemed credible, the next step is to determine the nature of the threat. This can be done by reviewing the information and identifying the specific threat being posed. Once the nature of the threat has been determined, the next step is to develop a response plan. This plan should outline the steps that will be taken to address the threat and should be reviewed and updated regularly. Finally, the response plan should be implemented and the situation should be monitored closely to ensure that the threat is being addressed effectively.



nearly one-and-a-half times as large as the median teeth: three marginal teeth subequal and slightly smaller than the submedian on each side. Epipharyngeal surface with fine bristles: clypeus (CLP) large and conspicuous somewhat rounded posteriorly. Both the mandibles (MND) in excellent state of preservation, showing the characteristic shape and structure of the predatory dytiscid larvæ: sickle-shaped, more than three times as long as thick at the base: mandibular condyle with a diameter little less than one-seventh the width of the mandible at the base. Maxilla (MXP) largely damaged, represented by only a part of the maxillary palpus of one side *in situ* the other detached from the body along with the mandible of that side. Trunk segments practically completely damaged with thorax and abdomen crushed and superimposed in a tangled mass of overlapping membranes, damaged sclerites and broken setæ.

#### Measurements

Head: length 0.408 mm.; width 0.402 mm.  
Labrum: length 0.101 mm.; width 0.154 mm.  
Mandible: length 0.208 mm.; width 0.072 mm.

Department of Zoology, V. P. GEORGE.  
St. John's College.  
Agra, July 24, 1968.

1. Andrew Murray, "Notes on some fossil insects from Nagpur." *Quart. J. nat. Zool. Soc.*, 1860, 12, 182
2. Mani, M. S., *The Indian Jour. Ent.*, 1946, 8(1), 53.

#### OIL PALM, *ELAEIS GUINEENSIS* JACQ. A NEW HOST FOR *STEPHANITIS* *TYPICUS* DIST.

THE lace wing bug *Stephanitis typicus* Dist. was reported by Shanta and Menon<sup>1</sup> as the vector of the root (wilt) disease of coconut. Although this insect breeds freely on coconut leaves it was considered unsuitable for that purpose in our transmission trials due to the lack of disease-free material in the locality. While searching for an alternate host a number of other palms were tested and it was found that oil palm, *Elaeis guineensis* Jacq. was an excellent material to breed the insect on, in the laboratory.

Observations on presence of nymphs and adults and feeding marks on leaves of 5-year old seedlings of oil palm var. Deli × P, seeds received from Chemara Plantations, Layang-Layang Malaya growing at the Central

Coconut Research Station Farm, were taken to study the infestation under normal conditions. Feeding marks were noticed on 42 seedlings on leaves of outer whorls as well as on young leaves. Nymphs and adults were present only on two seedlings.

In a mixed plantation of coconut and oil palm, the former seems to be preferred by the insect. However, the presence of nymphs and adults on two seedlings and the presence of feeding marks on all leaves of some others indicate that oil palm is also infested by the insect under natural conditions. This is of interest since oil palm is being newly introduced in Kerala as a promising commercial crop. Nothing is known about its susceptibility to root wilt disease although seedlings inoculated mechanically with diseased leaf extract have not shown any symptom so far.

Central Coconut Research Station, THOMAS JOSEPH.  
Kayangulam, P. SHANTA.  
Kerala, July 4, 1968.

1. Shanta, P. and Menon, K. P. V. *Trop. Ag.*, 1960, 12, 307.

#### FREE AMINO-ACIDS IN HEALTHY AND VIRUS-INFECTED CHRYSANTHEMUM

PLANT viruses influence the metabolism of the host plant considerably. Changes in most of the plant constituents have been reported.<sup>1</sup> Similarly, several workers have studied the changes in amino-acids caused by viruses.<sup>2,3,4</sup> However, information on the free amino-acid contents of chrysanthemum infected with virus is limited. The comparative changes in free amino-acids of the tolerant and susceptible hosts may elucidate the differential changes and suggest the use of some analogues as advocated by Raychaudhuri and Mishra.<sup>5</sup>

Therefore, the present investigation has been conducted to study the difference in free amino-acids in the different cultivars of chrysanthemums exhibiting severe, mild, and no stunting in the plants infected with chrysanthemum stunt virus (csv).

Uniform chrysanthemum suckers, six weeks old, were infected mechanically with csv with the aid of 600 mesh carborundum powder after 15 days of transplanting.

Composite samples of the leaves were taken from the infected and non-infected plants,

Samples for free amino-acids were prepared and analysed by paper chromatography.<sup>7-12</sup>

The cultivars, K-1, AA, and T-13 (NBG collection numbers) exhibited the different degree of stunting and were grouped as tolerant (no stunting), mild susceptible (6.1 to 35.8% stunting), and very susceptible (52.2 to 87.4% stunting) as compared to control. Table I indicates that each cultivar of chrysanthemum contained 6 to 9 amino-acids. Glycine was found in all cultivars, while histidine and phenylalanine were present only in AA and K-1 cultivars respectively.

TABLE I

Effect of csv on the free amino-acids and amides of chrysanthemum leaves

Sl. No.	Amino-acids	K-1 Tolerant		AA Mild Susceptible		T-13 Very Susceptible	
		Non-infected	Infected	Non-infected	Infected	Non-infected	Infected
1	Alanine ..	*	*	-	-	-	*
2	Asparagine ..	*	*	*	*	-	-
3	Aspartic acid ..	*	*	-	-	-	-
4	Arginine ..	-	-	-	-	*	*
5	Citrulline ..	-	-	-	-	*	*
6	Ethionine ..	*	*	*	*	*	*
7	Glutamic acid ..	-	-	*	*	*	*
8	Glycine ..	*	*	*	*	*	*
9	Histidine ..	-	-	*	*	-	-
10	Leucine ..	-	-	-	*	*	*
11	Lysine ..	-	-	-	-	*	*
12	Methionine ..	*	*	-	-	*	*
13	Phenylalanine ..	*	*	-	-	-	-
14	Proline ..	-	-	*	*	*	*
15	Serine ..	-	-	-	-	*	*
16	Tryptophan ..	-	-	-	*	-	-
17	Valine ..	-	-	*	*	-	-

\* Present, - Absent.

There was no qualitative change in free amino-acids of non-infected and infected plants of tolerant cultivars. The infected plants showing mild stunting lacked histidine and contained tryptophan in addition as compared to non-infected plants. The samples obtained from severe stunted plants exhibited 4 amino-acids (glycine, proline, methionine and ethionine) less and only one amino-acid (alanine) more as compared to samples from healthy plants.

The above findings indicate that as the degree of stunting caused by csv increases, the number of amino-acids decreases.

Screening trials for tolerance may provide an indicator plant. The tests for screening

and use of amino-acids analogues for control are in progress.

An increase in aspartic acid, glycine, and alanine was observed in infected leaves of tolerant cultivars. The contents of glycine and alanine may be greater because of degradation of nucleic acid.<sup>13</sup> The increase of aspartic acid and alanine agrees with the reports of Welkie *et al.*<sup>14</sup> and Ramaiah *et al.*<sup>15</sup> Further, mild susceptible plants showed the absence of histidine from infected leaves which is according to the findings of Gerola and Grilli<sup>4</sup> and Tremaine<sup>13</sup> which reported the decrease in histidine. In case of very susceptible plants, the number of amino-acids decreased more and it may be due to a great set-back to the physiological status of the host plant which is influenced much as compared to mild susceptible or tolerant plants.

National Botanic Gardens. B. P. SINGH.\*  
Lucknow. July 26, 1968. A. K. MISHRA.\*\*

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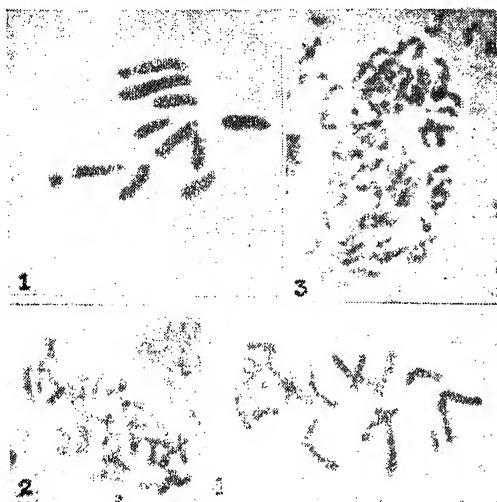
\*\* Junior Research Fellow, National Botanic Gardens, CSIR.

1. Allison, R. M., *Nature*, 1953, 171, 573.
2. Diener, T. O., *Phytopathology*, 1960, 50, 141.
3. Fife, J. M., *J. Am. Soc. Sugar-beet Technologists*, 1956, 9, 207.
4. Gerola, F. M. and Grilli, M., *Publ. Univ. Cattolica S. Cuve, Ann. Fac. Agrar.*, 1960, 78 (2), 13.
5. Govindjee, M. M., Lalraya and Rao, T. R., *Experientia*, 1956, 12, 180.
6. Harpaz, I. and Applebaum, S. W., *Nature*, 1961, 192, 750.
7. Levy, A. L. and Chung, D., *Anal. Chem.*, 1953, 25, 396.
8. Markham, R. and Smith, J. D., *Nature*, 1949, 164, 1052.
9. Portar, C. A., *Ann. Virus Res.*, 1959, 6, 75.
10. Ramaiah, P. K., Babu, D. R. C. and Rao, P. S., *Prac. Ind. Acad. Sci.*, 1964, 60 (4) B, 281.
11. Raychaudhuri, S. P. and Mishra, M. D., *Indian Phytopathology Soc. Bull.*, 1963, 1, 31.
12. Singh, B. P. and Biggs, R. H., *Ind. Jour. Hort.*, 1965, 22 (2), 162.
13. Tremaine, J. H., *Virology*, 1960, 30 (3), 348.
14. Welkie, G. W., Yang, S. F. and Miller, G. W., *Phytopathology*, 1967, 57 (5), 472.

### CHROMOSOMAL VARIABILITY IN THE INDIAN SQUILL (*URGINEA INDICA* KUNTH.)

The normal diploid complement of chromosomes of *Urginea indica* Kunth. has been determined to be 20. Previous records, however, do not seem to indicate the occurrence of haploid, triploid, tetraploid and octoploid chromosome complements in the somatic cells of *U. indica*.

Normal root tips were fixed in 1 : 3 acetic alcohol for periods ranging between 3-24 hours. They were hydrolyzed for 7-10 minutes in  $\text{NHCl}$  and after a thorough wash in distilled water, transferred to 5% iron alum where they were allowed to stay for 15 minutes. These root tips were again washed well with distilled water, stained in 0.5% hæmatoxylin for 30 minutes<sup>6,7</sup> and finally mounted on a slide in a drop of 50% acetic acid.



FIGS. 1-4

The somatic cells contain rare instances of haploid ( $n=10$ ; Fig. 1), triploid (Fig. 2;  $3n=30$ ), tetraploid ( $4n=40$ ) and octoploid ( $8n=80$ ) cells (Fig. 3), in addition to the normal diploids with 20 (Fig. 4) chromosomes. The frequency of occurrence of tetraploid and octoploid cells in relation to haploid and triploid complements is very small. It is presumed that tetraploid and octoploid cells are formed as a result of an inhibition of spindle formation.

It has been held<sup>2</sup> previously that the chances of occurrence of cells with a viable haploid complement of chromosomes is much smaller than that of gene mutations. This phenomenon of somatic reduction has been described previously in other plants<sup>2-8</sup> and considered to be very rare in diploids, although fairly common in polyploids.<sup>9-13</sup>

Dept. of Botany, V. DHANAMJAYA MOORTHY.  
Annamalai Univ., R. SAMPATHKUMAR.  
Annamalainagar,  
June 22, 1968.

1. Raghavan, T. S., *J. Indian bot. Soc.*, 1935, **14**, 151.
2. Srinivasachar, D. and Patau, K., *Chromosoma*, 1958, **9**, 229.
3. Huskins, C. L., *Jour. Hered.*, 1948, **39**, 311.
4. Srinivasachar, D., *Cytologia*, 1958, **23**, 419.
5. Makinen, Y., *Ann. Bot. Zool. Bot. Fenn., Vanamo*, 1963, **34**, 1.
6. Royan Subramanyam, S., *Curr. Sci.*, 1964, **33**, 203.
7. Subramanyam, S., *Ibid.*, 1964, **33**, 217.
8. Ayyangar, K. R. and Sampathkumar, R., *Ibid.*, 1967, **36**, 470.
9. Vaarama, A., *Hereditas*, 1947, **33**, 191.
10. Brown, M. S., *Amer. Jour. Bot.*, 1947, **34**, 384.
11. Huskins, C. L. and Chouinard, L., *Genetics*, 1950, **35**, 115.
12. Menzel, M. V. and Brown, M. S., *Amer. Jour. Bot.*, 1952, **39**, 59.
13. Chen, C. H. and Ross, T. G., *Jour. Hered.*, 1963, **54**, 96.

### SOME FURTHER OBSERVATIONS ON THE EMBRYOLOGY OF *CALTHA* *PALUSTRIS* LINN.

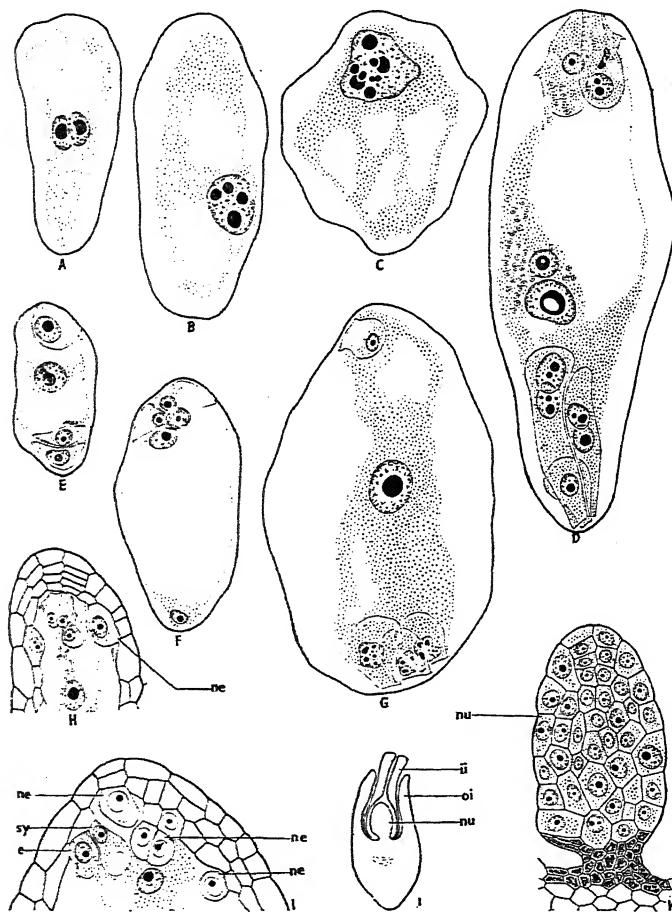
KAPIL AND JALAN (1962) published a paper entitled 'Embryology of *Caltha palustris* Linn.'. Apart from the structure of seedcoat, they noted that the ovules are bitegminal, crassinucellate, and anatropous. The embryo-sac is of the Polygonum type, and possesses large, persistent antipodal cells having polyploid nuclei. The endosperm is nuclear and the embryo conforms to the Onagrad type of development. Since these data, the present author has made some additional observations on *Caltha palustris* described as follows.

The material of *C. palustris* was obtained from various places such as Belgium, Berlin, Copenhagen, Ithaca, Manchester, Oxford, Petersham, Reading, Srinagar, Stockholm, Swansea, Wisconsin, and Zürich through the courtesy of late Professor P. Maheshwari. Of all these collections, only the one obtained from 'Copenhagen' showed peculiarities which were not seen in any other collection of this species. Nearly 75% of the ovules showed abnormality of one kind or the other. To put it differently the abnormal features in this collection seems to be a normal phenomenon.

The ovules are crassinucellate and bitegminal. Of the four linearly arranged megaspores, only the lowest one-functions. In certain instances meiosis occurs in the megaspore mother cell but after the first division itself, wall formation fails and the resulting daughter nuclei are of unequal size. The normal megaspore undergoes three mitotic divisions producing two-, four-, and eight-nucleate embryo-sacs of the Polygonum type. Further

development of these embryo-sacs is unusual as mostly the nuclei fuse producing irregular polyploid masses (Figs. A-C). Consequently the egg apparatus, polar nuclei, and the antipodal cells fail to organise in such ovules. In instances when a normal embryo-sac develops with all its components it is ephemeral and rarely matures to form the endosperm and the embryo. Frequently the functioning megaspore produces embryo-sacs containing more or less

(Fig. D), or there may be only an egg cell, a single polar nucleus, and two antipodal cells in it (Fig. E). Not uncommonly, while the egg apparatus is complete in an embryo-sac, there is only a single polar nucleus and a solitary antipodal cell (Fig. F). Contrary to such embryo-sacs there are also those which have a fully developed antipodal apparatus, a primary endosperm nucleus, an egg cell but no synergids (Fig. G).



FIGS. A-K. *Caltha palustris*. Figs. A-C. Two-, four- and eight-nucleate embryo-sacs showing fusion of nuclei,  $\times 550$ . Fig. D. Embryo-sac containing an extra nucleus lying adjacent to the primary endosperm nucleus,  $\times 550$ . Fig. E. A four-nucleate embryo-sac showing the egg cell, a polar nucleus and two antipodal cells,  $\times 640$ . Fig. F. A five-nucleate embryo-sac with an egg apparatus, a polar nucleus and an antipodal cell,  $\times 370$ . Fig. G. Another five-nucleate embryo-sac containing an egg cell, a polar nucleus and three antipodal cells,  $\times 370$ . Figs. H-I. Micropylar portions of embryo-sacs enlarged to show nucellar proembryos,  $\times 370$ . Fig. J. An atypical ovule, diagrammatically sketched,  $\times 63$ . Fig. K. Enlargement of the nucellar portion from 'J',  $\times 370$ . (e, Egg cell; ii, inner integument; ne, nucellar embryos; nu, nucellus; oi, outer integuments; sy, synergids.)

than eight nuclei (Figs. D-G). In these an embryo-sac may have an extra nucleus lying adjacent to the primary endosperm nucleus

None of the egg cells showed any evidence of syngamy or triple fusion, and the egg apparatus degenerated sooner or later as such.

Abnormality is, however, seen in the ingrowth of nucellar cells which eventually develop into embryonal masses (Figs. H, I). Like the egg cell, each of these cells is plasma rich, prominently nucleate, and divides transversely and vertically to produce four-celled proembryos lying near the egg apparatus (Fig. I). It is still interesting that within the same ovule, the different nucellar embryos may be in varying stages of development.

Some of the ovules showed a still unique phenomenon. In these cases instead of gametogenesis, the whole of nucellar tissue shrunk, and the cells became thick-walled, plasma rich, and prominently nucleate (Figs. J, K).

What are referred as abnormal embryological features, thus seems to be a normality for the 'Copenhagen' collection of *Caltha palustris* sent by Prof. Hagerup. In all findings such as the fusion of embryo-sac nuclei at various phases, organization of the embryo-sacs having more or less than the usual eight nuclei, and nucellar polyembryony the 'Copenhagen' collection differed from all others of this species which showed typical embryological characters (Kapil and Jalan, 1962). A question, therefore, naturally arises if the 'Copenhagen' material belongs to a polyploid population of *C. palustris*. In the years 1950 and 1951, Leoncini published his observations on the cytology of *Caltha*, and found that different populations of *C. palustris* included tetraploids and even hexaploids. The variations as observed above in the embryology of *C. palustris* thus seems to be perhaps polyploidy based. It may also be noted that several other Ranunculaceae also show a more or less similar phenomenon. Häflinger (1943) examined *Ranunculus auricomus* and attributed variations such as pollen of different sizes, formation of stomatic embryo-sacs, and the lack of fertilization in this species to polyploidy. Perjé (1952) also related the abnormal development of pollen, embryo-sacs, and variations in the floral organs of different populations to polyploidy in *Ranunculus ficaria*.

Thanks are due to Dr. H. C. Arya and to late Professor P. Maheshwari, F.R.S., and Dr. R. N. Kapil for interest.

Department of Botany, S. JALAN.  
University of Rajasthan, Jaipur-4, June 1, 1968.

1. Häflinger, E., *Ber. Schweiz. Bot. Ges.*, 1943, **53**, 317.
2. Kapil, R. N. and Jalan, S., *Plant Embryology—A Symposium*, New Delhi, 1962
3. Leoncini, M. L., *Caryologia*, 1950, **3**, 336.
4. —, *Ibid.*, 1951, **4**, 367
5. Perjé, A. M., *Arkiv. Bot.*, 1952, **2**, 251.

## A NEW SPECIES OF *CONIOTHYRIUM* CORDA

In the course of the study of *Sphaeropsidales* of Jodhpur, the author recorded a species of *Coniothyrium* on the leaves of *Thuja orientalis* Linn. In the beginning small reddish-yellow marginal or apical spots were observed. At maturity the spots turned olive-buff from central region surrounded by light red strips. Subsequently black pycnidia appeared in the diseased portions. The culture and material were sent to C.M.I., Kew, where they were examined by Dr. Punithalingam but could not be assigned to any of the existing species. Due to distinct variations in dimensions from the other existing species, the isolate is being described as a new species.

### *Coniothyrium thujae* SPEC. NOV.

Colonies spreading, light gray in beginning, dark olive at maturity; hyphae hyaline to light brown, closely septate, poorly branched, 2.4–3.4  $\mu$  wide; pycnidia superficial, usually globose or spherical, rarely with an elongated neck, with or without ostiole, 13.5–16.2  $\mu$  wide, separate or aggregated, olive yellow to dark olive, 76.6–352.8  $\mu$  in diam. (average 212.2  $\mu$ ). wall persistent, one to two layered thick; conidiophores simple, short, erect, light yellow to light olive in colour, 3.7–5.4  $\mu$  long; conidia usually oval, 5.6–9.5  $\times$  3.8–7.6 (average 8.6–4.2)  $\mu$ , occasionally spherical to globose, 3.8–8.1  $\mu$  in diam. (average 5.6  $\mu$ ) hyaline to light yellow when young, dark olive at maturity. Isolated from the leaf spots of *Thuja orientalis* Linn. Culture deposited at C.M.I., Kew, Herb. No. 130820.

### *Coniothyrium thujae* SPEC. NOV.

Coloniae patentes, primo pallide griseae, tum fusco olicaseae; mycelium hyalinum vel pallide brunneum, arcte septatum, paupercule ramosum, 2.4–3.8  $\mu$ , latum; pycnidia superficialia, vulgo globosa vel sphaerica, raro rostro elongato ornata, ostiolo praesenti vel nullo, 13.5–16.2  $\mu$  lata, distincta vel aggregata, olivacea vel fusco olivacea, 76.6–352.8  $\mu$  diam. (mediet 212.2  $\mu$ ), parietibus persistentibus, uni-vel bis-seriatis; conidiophora simplicia, brevina, erecta, pallide lutea vel pallide olivacea, 3.7–5.4  $\mu$  longa; conidia vulgo ovalia, 5.6–9.5  $\times$  3.8–7.6 (mediet 8.6–4.2)  $\mu$ , interdum sphaerica vel globosa, 3.8–8.1  $\mu$  diam. (mediet 5.6  $\mu$ ), hyalina vel pallide lutea primo, ad maturitatem fusco-olivacea.

Lectus in foliis *Thuja orientalis* Linn.  
Cultura posita in CMI, ad Hort. Kewensem,  
sub numero 130820.



FIG. 1. Photomicrograph of the pycnidia,  $\times 189$ .

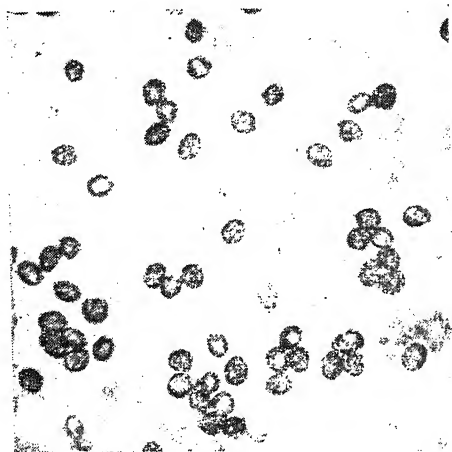


FIG. 2. Photomicrograph of the conidia,  $\times 750$ .

The author expresses his grateful thanks to Dr. K. S. Bilgrami for guidance, and to Prof. H. Santapau for Latin diagnosis. The help received from Dr. G. C. Ainsworth, Director, C.M.I., Kew, and Dr. Punithalingam is gratefully acknowledged.

Botany Department, J. L. SHREEMALI,  
University of Jodhpur, Jodhpur, July 24, 1968.

1. Butler, E. J. and Bisby, G. R., *The Fungi of India*, Indian Council of Agricultural Research, New Delhi, India, 1960.
2. Saccardo, P. A., Various papers in *Sylloge Fungorum*, published during years 1884-1931.
3. Sahani, V. P., "Deuteromycetes from Jabalpur—II," *Mycopath. et Mycol. Appl.*, 1966, 29, 226.
4. Tandon, R. N. and Chandra, S., *University of Allahabad Studies, Botany Section, Supplement to the List of Indian Fungi*, 1962.
5. Vasudeva, R. S., *Fungi of India*, Supplement 1, Indian Council of Agricultural Research, New Delhi, India, 1962.

## CYTOLOGY OF WILSON'S *CAMELLIA* (*C. IRRAWADIENSIS* BARUA)

BARUA<sup>1</sup> described Wilson's *Camellia* as *C. irrawadiensis* P. K. Barua sp. nov., the original habitat of which is in the Kachin Hills of Upper Burma between 26-27° N and 98-90° E. and at an altitude of 2,300 m. The only known plant of the species exists today at the Tocklai Experimental Station and was raised from seeds collected by L. O. Wilson in 1917 from the area where a plant with somewhat distinct morphological features was found growing wild by the side of the village cultivated Kachin tea. Five plants were raised at Tocklai from the seeds sent by Wilson, only one of which survived and is that described by Barua<sup>1</sup> as *C. irrawadiensis*.

*C. irrawadiensis* resembles *C. sinensis* var. *assamica* (Assam tea) in its morphological features but it differs markedly from *C. sinensis* var. *sinensis* (China tea) and *C. taliensis*. The species can be easily distinguished from the cultivated Assam tea by its anatomical features and chemical constituents, notably in the morphology of leaf sclereids (Barua and Wight)<sup>2</sup> and absence of caffeine (Roberts, Wight and Wood).<sup>3</sup>

The plant is self- and cross-incompatible but in order to explore the possibilities of utilising the inherent vigour of this species in the breeding of tea, and therefore to understand its incompatibility system, cytological investigations on the species were carried out recently at Tocklai. The present paper is a record of the number and morphology of its chromosomes.

Karyotype was studied from the leaf-tip squashes by the method described in an earlier paper (Bezbaruah).<sup>4</sup> For meiotic studies flower-buds of appropriate size were fixed in 1 : 3 : 6 propionic acid : chloroform : ethanol for 12 hours and stained in 1% propionocarmine. Slides were made permanent following usual methods. The idiogram was drawn on graph paper and then printed on photographic paper by contact process. Copies from the camera-lucida drawings were also made by the same method.

The chromosome number of the species is found to be  $2n = 30$  (Fig. 1). Length of the chromosomes varies from  $2.4 \mu$  to  $3.4 \mu$  with an average diameter of  $1.0 \mu$ . The total length of the chromosome complement is  $85.8 \mu$ . According to their length and centromeric

position, the complement can be divided into the following groups:

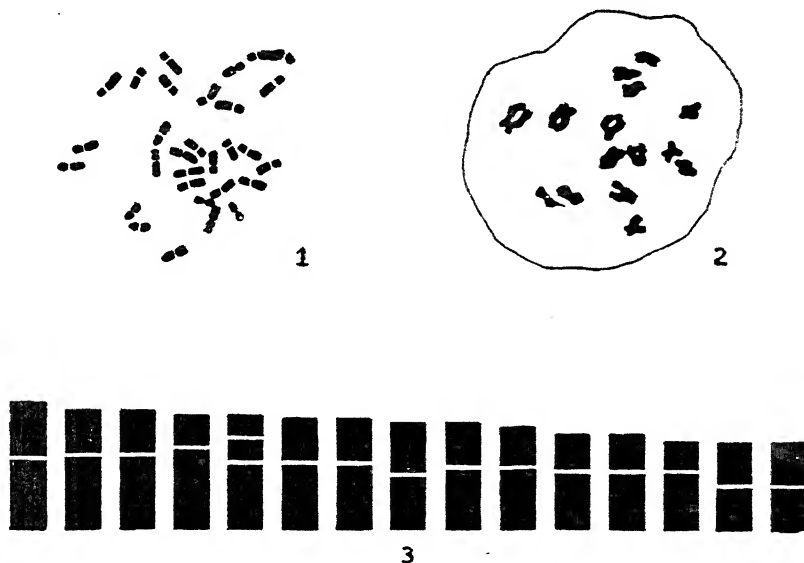
1. Five pairs of long chromosomes with sub-median primary constriction ( $3.4\mu$  to  $3.0\mu$ ).
2. One pair of long chromosomes with sub-terminal primary constriction ( $3.1\mu$ ).
3. One pair of long chromosomes with both sub-median primary constriction and secondary constriction ( $3.0\mu$ ).
4. One pair of medium-sized chromosomes with median primary constriction ( $2.9\mu$ ).
5. Four pairs of medium-sized chromosomes with sub-median primary constriction ( $2.6\mu$  to  $2.9\mu$ ).
6. One pair of small chromosomes with sub-terminal primary constriction ( $2.4\mu$ ).
7. Two pairs of small chromosomes with median primary constriction ( $2.4\mu$ ).

Various authors (Darlington and Wylie,<sup>5</sup> Longley and Tourje<sup>6</sup>) studied the cytology of different *Camellia* species including tea, the basic number for which is  $n = 15$ . The present cytological investigations on *C. irrawadiensis* reveal, from both mitotic and meiotic divisions, that this plant is also a diploid with  $n = 15$  and  $2n = 30$ .

Further studies on the incompatibility system and its inheritance in relation to tea are in progress.

The author is grateful to Dr. D. N. Barua, Senior Botanist, for his keen interest in the work and to Mr. D. H. Laycock, Director, Tocklai Experimental Station, for his valuable advice and for permission to publish the results.

Tocklai Experimental Station,  
H. P. BEZBARUAH.  
Jorhat 8, Assam, July 30, 1968.



FIGS. 1-3. Fig. 1. Somatic metaphase plate showing  $2n = 30$  chromosomes,  $\times 2,500$ . Fig. 2. First meiotic metaphase showing 15 bivalents,  $\times 2,500$ . Fig. 3. Idiogram of the somatic chromosomes of *C. irrawadiensis*.

The long and short arm ratio and the centromere position of each chromosome is graphically represented in the idiogram (Fig. 3).

Meiotic studies reveal that the 15 pairs of chromosomes associate perfectly and form 15 clear bivalents during the first metaphase (Fig. 2). Anaphase separation and the second division have also been observed to be regular, resulting in the formation of four microspores from each pollen mother cell.

1. Barua, P. K., "Wilson's *Camellia*," *Camellian*, 1956, 7, 18.
2. — and Wight, W., *Phytomorphology*, 1958, 8, 257.
3. Roberts, E. A. H., Wight, W. and Wood, D. J., *The New Phytologist*, 1960, 57, 211.
4. Bezbaruah, H. P., *Stain Technology*, 1968 (In press).
5. Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, George Allen & Unwin, London, 1961.
6. Longley, A. E. and Tourje, E. C., "Chromosome numbers of certain *Camellia* species and allied genera," *American Camellia Year-Book*, 1959, p. 33.

# EXOCELLULAR CATALASE PRODUCED BY A STRAIN OF *RHIZOPUS NIVEUS*

WIDESPREAD utilization of hydrogen peroxide in industry and its formation during processing of certain commodities have necessitated the use of catalase for breaking down the substrate. Commercial catalase is obtained mainly from animal sources. Occurrence of catalase in micro-organisms has been reported by various authors.<sup>1-6</sup> Among fungi, *Aspergilli* and *Penicillia* have been reported to secrete this enzyme.<sup>7-8</sup> So far the attention has been focused to the catalase present within the cells of the organisms. In this laboratory, it was observed that a strain of *Rhizopus niveus* (CFTRI, 1053) was capable of secreting this enzyme into the culture medium. This fungus was cultivated on two types of media, viz., liquid and solid substrates and the catalase produced by this organism is recorded. In the former case, inoculated flasks were maintained under both stationary and shaking conditions.

Liquid medium was prepared from wheat-bran extract, defatted peanut meal and other inorganic nutrients. Erlenmeyer flasks containing 100 ml. of the medium were sterilised at 15 psi for 20 minutes and inoculated with a spore suspension of the fungus. One set of flasks was kept on laboratory bench and another set kept on a rotary shaker revolving at 230 r.p.m. with a stroke of 5 cm. Samples were drawn periodically and their catalase activities were determined by Baker's method.<sup>4</sup> The results are presented in Table I.

TABLE I  
Catalase activity of culture filtrates of  
*R. niveus*

Growth period in hours	Activity/u.l.	
	Shaker	Stationary
48	0.16	0.12
72	0.20	0.20
96	0.20	0.20
120	0.20	0.20
192	0.40	0.20
216	0.52	0.24
278	0.12	0.08

Wheat-bran was moistened with dilute HCl (at 10:6 ratio) containing traces of Zn, Cu and Fe (used as sulphates) and was dispensed into 100 ml. wide-mouth Erlenmeyer flasks at the rate of 16 g. The material was autoclaved at 15 psi for 45 minutes. After inoculation with a spore suspension of *Rhizopus niveus*, the bran was mixed well and kept on laboratory bench. Samples were drawn after specified period of growth and the enzyme

was extracted from the mouldy bran with cooled water using 5 ml. of water per g. of dry material. The catalase activity of the different extracts are presented in Table II.

TABLE II  
Catalase activity of mouldy bran of  
*R. niveus*

Growth period in days	Catalase activity/g.
2	1.0
3	1.25
4	1.25
5	1.40
6	1.60
7	1.60
10	1.00
15	0.40
16	Nil

The results indicate that extra-cellular catalase is produced by *Rhizopus niveus*. On liquid medium, secretion of enzyme is accelerated by aeration. There is gradual increase in the enzyme content of the culture filtrate upto 9 days after which there is sudden decline in the activity. On wheat-bran medium maximum enzyme secretion takes place within 6 days. On this substrate the reduction of enzyme activity is gradual and there is complete loss of activity only after 15 days. Clayton<sup>9</sup> has demonstrated that synthesis of catalase is induced in *Rhodospseudomonas sphaeroides* on aeration. On wheat-bran, the enzyme obtained is significantly higher than in liquid culture.

The authors wish to express their gratitude to Dr. H. A. B. Parpia, Director, C.F.T.R.I., Mysore, for continued interest and useful suggestions.

K. R. SREEKANTIAH.

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Discipline of Microbiol.,  
Central Food Tech. Res.  
Inst., Mysore, July 29, 1968.

- Herbert, D. and Pinsent, J., *Biochem. J.*, 1948, **43**, 193.
- Clayton, R. K., *Biochemica et Biophysica Acta*, 1959, **36**, 40.
- Cole, E. H. and Hinshelwood, C. N., *Trans. Faraday Soc.*, 1947, **43**, 266.
- White, D. C., *J. Bacteriol.*, 1962, **83**, 851.
- Hilmer, A. E., Ishibashi, S. T., Reid, A. and Ho, J. S., *Appl. Microbiol.*, 1963, **11**, 151.
- Sulebele, G. A. and Rege, D. V., *Curr. Sci.*, 1967, **37**, 13.
- Baker, D. L., *U.S. Patent* 2635069 (April 14), 1953.
- Scott, D. and Hammer, F. E., *Enzymol.*, 1960, **22**, 194.
- Clayton, R. K., *Biochemica et Biophysica Acta*, 1960, **37**, 503.



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## REVIEWS AND NOTICES OF BOOKS

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Annual Review of Medicine (Vol. 19). Edited by Arthur C. DeGraff. (Annual Reviews, Inc. 4139 El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. viii + 540. Price \$9.00.

Volume 19 of this well-known series contains the following articles: Complement in Human Disease; Chronic Hepatitis; Cholestasis; Digestive-Absorptive Surface of the Small Bowel Mucosa; Asiatic Cholera; Drug Resistance of Parasites Causing Human Malaria; Physiological Basis of Diuretic Action; Circulatory Adaptation to High Altitude; Respiratory Distress Syndrome of the Newborn; Peripheral Vascular Resistance; The Fetal Circulation; Cardiac Valvular Replacements; Role of the Aortic Homograft; Control Mechanisms in Human Haemoglobin Synthesis; Transfusion of Specific Plasma Components; Fibrinolysis; Malignant Lymphoproliferative Diseases; Interactions between Immunological Abnormalities and Oncogenic Viruses; Growth and Physiological Development during Adolescence; Radiological Techniques in Intracranial Disease; Pulmonary Clearance of Infectious Agents; Keratinization and Hair Growth; Induction of Ovulation; Aldosterone, The Adrenal Cortex, and Hypertension; Endocrine Relations between Mother and Fetus; Bacteriuria of Pregnancy—A Critical Appraisal; and Intrauterine Viral Infections.

C. V. R.

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Chemistry and Physics of Carbon (Vol. 3). Edited by Philip L. Walker, Jr. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. (10016), 1968. Pp. xii + 449. Price \$22.75.

Following the objectives of this monograph series as outlined in Volume 1, Volume 3 of the *Chemistry and Physics of Carbon* is concerned with recent advances in carbon research and development and with comprehensive reviews of past achievements in important areas of carbon.

New studies revealing non-basal dislocations in graphite, optical studies of carbon, and the action of oxidizing gases on the gasification of carbons are among the topics critically discussed in this third volume of the series. Comprehensive examinations of studies of carbon

by X-ray diffraction and carbon transport studies for helium-cooled high-temperature nuclear reactors are also included. The interdisciplinary approach of the series is evidenced by the fact that the authors of this volume, as of the other volumes, include organic chemists, physical chemists, solid-state physicists, electrochemists, chemical engineers, and materials scientists, each an expert of international repute in his respective field.

The titles of the chapters contained in this volume are listed below: Non-basal Dislocations in Graphite; Optical Studies of Carbon; Action of Oxygen and Carbon Dioxide above 100 Millibars on "Pure" Carbon; X-Ray Studies of Carbon; and Carbon Transport Studies for Helium-Cooled High-Temperature Nuclear Reactors.

C. V. R.

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Chemical Analysis Without HS. By K. N. Johri (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1). Pp. 76. Rs. 6.00.

The author has successfully developed the technique of chemical analysis using (PTC) potassium trithiocarbonate ( $K_2CS_3$ ) in the place of the conventional hydrosulphide as the reagent. This new technique is gaining popularity in the teaching of chemistry in schools and colleges. The issue of the first edition of this book and the ready availability of PTC, added to the general preference to semi-micro-analysis in laboratories, have all contributed to the growing interest in this new method.

In this second revised edition a chapter has been introduced on semi-micro techniques, and consequent upon this the chapters on conventional (macro) analysis have been abridged to a certain extent.

A. S. G.

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Books on Chemistry Problems: Published by Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London W. 1.

1. *Problems for Introductory University Chemistry*. By J. N. Butler, B. A. Dunell and L. G. Harrison. Pp. 213. Price 22 sh.
2. *Study Problems in Organic Chemistry*. By D. W. Hutchinson. Pp. 144. Price 26 sh.

The first book by three authors is addressed to the first year university students in chemistry. The authors have selected a collection

of about 250 problems which have been devised by them and their colleagues for use at the University of British Columbia. The 88 pages of problems are followed by 16 pages of Hints on solutions, and 105 pages of Complete solutions.

The *Study Problems* by Hutchinson is intended for serious students of organic chemistry. A special feature is that the selected problems have been taken directly from the literature, thus attempting to bring the student in contact with original papers and affording scope for a greater reading and understanding of the subject. The book is in two sections. The first section of about 50 pages contains the selected 127 problems arranged in three nearly equal groups Introductory, Intermediate, and Advanced. The second section of 100 pages contains the solutions, explanatory notes, and reference to literature.

A. S. G.

**Plant Virus Names.** Edited by E. B. Martyn. Commonwealth Mycological Institute, Kew, Surrey, England, 1968, Pp. 264, Price 30 sh.

This important CMI Publication (Phytopathological Papers, No. 9), contains an annotated list of names and synonyms of plant viruses and diseases. This is the third edition of the CMI listing of plant viruses and virus diseases, the second edition of which was published in 1957. In this edition the data contained in the second edition have been amended wherever necessary. Besides, it includes the very large number of new viruses that have been named in the last ten years. It also includes all records of viruses or suspected viruses that have been reported up to 1967. Such a complete list is not likely to be repeated for some years to come, as the future records may appear only as supplements from time to time. Hence the importance of this publication to all plant pathologists.

A. S. G.

**Rothamsted Experimental Station—Report for 1967.** (Rothamsted Experimental Station, Harpenden, Herts, England). Pp. 430. Price £ 1 post-free from the Librarian.

The Annual Report for the year 1967 of the Rothamsted Experimental Station contains the General Report of the Director, Sir Frederick Bawden, and the detailed reports of the

progress of works continued and newly initiated during the year, from the twelve departments of the Station, namely, Physics, Chemistry, Pedology, Soil Microbiology, Botany, Biochemistry, Plant Pathology, Nematology, Insecticides and Fungicides, Entomology, Bees, and Statistics.

The year's work on Field and Farm Experiments, and findings from the Woburn and Broom's Barn Experimental Stations are also reported. There are two review articles, one on Experiments with Ley and Arable Farming Systems, and the second Substitutes for Organochlorine Insecticides to control Soil Insects that attack Cereals. Sixty pages are devoted to Abstracts of Papers and Publications during the year from the various departments.

A. S. G.

### Books Received

**Sixth Symposium of the British Society for Parasitology—Immunity to Parasites.** Edited by A. E. R. Taylor. (Blackwell Scientific Publications, 5 Alfred Street, Oxford, England), 1968. Pp. vii + 118. Price 37 sh. 6 d.

**The Cultivation of Parasites in vitro.** By A. E. R. Taylor and J. R. Baker. (Blackwell Scientific Publications, Oxford, England), 1968. Pp. xiii + 377. Price 70 sh.

**Introduction to Modern Biochemistry** (3rd Edition). By P. Karlson (Academic Press, Inc., New York 10003), 1968. Pp. xix + 483. Price \$ 11.75.

**Marine Chemistry** (Vol. 1)—*Analytical Methods.* By D. F. Martin. (Marcel Dekker, Inc., New York 10016), 1968. Pp. viii + 280. Price \$ 5.75.

**Ultra-Violet and Visible Spectroscopy** (2nd Edition)—*Chemical Applications.* By C. N. R. Rao (Butterworth and Co., Pub. Ltd., London W.C. 2). Pp. xiii + 210. Price £ 2.10.0.

**Basic Concepts of Mathematics and Logic.** By M. C. Gemignani. (Addison-Wesley Publishing Co., West End House, London W. 1), 1968. Pp. 280. Price 75 sh.

**Elements of Statistical Thermodynamics.** By L. K. Nash. (Addison Wesley Publishing Co., West End House, London W. 1), 1968. Pp. vii + 128. Price 22 sh.

## DISTRIBUTION OF CESIUM-137 AND STRONTIUM-90 IN THE ARABIAN SEA AND BAY OF BENGAL

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THE relatively slow decay (less than 2% a year) of the fallout radionuclides, cesium-137 and strontium-90, facilitates their use as radioactive tags in the study of long-term processes in the oceans. This advantage is however offset by difficulties in sampling and measurement at sea. Consequently, the information regarding activity levels and distribution patterns of fallout in the seas is limited<sup>1-7</sup> and not so extensive as that available for fallout on land.<sup>8-11</sup> There is a paucity of information on the distribution of cesium-137 and strontium-90 in the Arabian Sea and Bay of Bengal.<sup>12-13</sup> The present paper reports the latitudinal distribution of cesium-137 and strontium-90 in the Indian Ocean as well as some values for the coastal waters off the West Coast of India.

Surface sea-water samples from the Arabian Sea and Bay of Bengal were collected on board 'INS Kistna' participating in the Indian Programme of International Indian Ocean Expedition during 1962-63. Coastal sea-water samples were collected during 1963-64 from four regional centres along the West Coast of India, namely, Veraval, Ratnagiri, Mangalore and Cochin. Near-shore and off-shore surface sea-water samples were collected during the Angria Bank Expedition in 1964.<sup>14</sup>

### ANALYTICAL METHODS

Surface sea-water samples were collected with polythene buckets and stored in polythene carboys. All preliminary steps were carried out in polythene containers.

#### STRONTIUM-90

Methods described by Sugihara *et al.*<sup>15</sup> and Sunderman and Townley<sup>16</sup> have been employed for the radiochemical separation of strontium-90. Strontium was precipitated as carbonate along with calcium by the addition of ammonium carbonate in the presence of ammonium chloride and ammonia. The separation of strontium from calcium was carried out using fuming nitric acid. Radium was removed by precipitating it with barium chromate. Other interfering fission product nuclides were

removed by ferric hydroxide scavenging and strontium was once again precipitated as carbonate with ammonium carbonate in the presence of ammonia. The purified strontium carbonate was allowed to stay for two weeks for strontium-90 to attain secular equilibrium with its daughter yttrium-90. The yttrium-90 was separated as hydroxide along with 20 mg. of yttrium carrier and counted in a low background (0.4 counts/minute) G. M. Counter. The chemical yield of this procedure was  $33 \pm 5\%$  from 60 litres of sea-water.

#### CESIUM-137

Cesium-137 was estimated by the method described by Schroeder and Cherry<sup>17</sup> with some minor modifications. Cesium was co-precipitated along with potassium using trisodium cobaltinitrite in acetic acid medium (pH 4-4.5). The precipitate was dissolved in 6N hydrochloric acid, 20 mg. of cesium carrier was added and the cesium was precipitated as the silicotungstate by the addition of a M/8 solution of silicotungstic acid. The solution was cooled with ice and allowed to stand overnight. The precipitate was washed twice with 6N hydrochloric acid and assayed for cesium-137 using a well type sodium iodide scintillation crystal coupled to a 10 channel pulse height analyser. The chemical yield of this method was  $74 \pm 13\%$ .

### RESULTS AND DISCUSSION

Results are given in Tables I, II and III.

Table I contains the latitudinal distribution of cesium-137 and strontium-90 as well as cesium-137 to strontium-90 ratios. The strontium-90 values are similar to those reported by Baranov *et al.*<sup>18</sup> A marked increase in fallout from south to north is evident from the data similar to the latitudinal variation of fallout on land reported by Alexander *et al.*<sup>5</sup> Hardy *et al.*<sup>9,10</sup> and Volchok.<sup>11</sup> The lower values in the region between 20°N and 24° 30'N in the Arabian Sea may be due to the influx of freshwater from the river Indus. The higher values of cesium-137 and strontium-90 in the region

between 15°N and 20°N. (downward shift in the maxima) may be attributed to the surface circulation patterns in the Arabian Sea during the months October and November when the samples were collected.<sup>19,20</sup> The lower values of fallout in the Bay of Bengal compared to those in the Arabian Sea again may be due to the influence of the high river discharge into the northern Bay of Bengal, as is evident from its lower salinity compared to any other oceanic area.<sup>21</sup>

TABLE I

Latitude-wise distribution of Cs-137 and Sr-90 (pC/100 l.) in the Arabian Sea and Bay of Bengal, 1962-63

Latitude	Arabian Sea		Bay of Bengal	
	Cs-137	Sr-90	Cs-137/Sr-90	Cs-137/Sr-90
06° 00' - 10° 00' N	20 (16)*	12 (14)	1.7	17 .. .. (4)
10° 00' - 15° 00' N	24 (13)	13 (5)	1.9	23 14 1.4 (4) (1)
15° 00' - 20° 00' N	28 (16)	11 (16)	2.5	22 9 2.4 (2) (1)
20° 00' - 24° 30' N	21 (5)	7 (3)	3.0	.. .. ..

\* Number in bracket indicates the number of samples analysed.

The cesium-137 to strontium-90 ratio varies from 1.4 to 3.1. Similar variations have been reported by Salo and Voipio<sup>22</sup> in Baltic waters. These also show higher values in the northern latitudes. No explanation is offered for either the high cesium-137 to strontium-90 ratio or the increasing ratios with latitude.

Table II presents values for cesium-137 and strontium-90 for some coastal sea-water samples collected off the West Coast of India. There is no marked increase in the values from south to north. Again high cesium-137 to strontium-90 ratios have been found in these samples except in one sample collected from the mouth of the Cochin Harbour.

In Table III are presented cesium-137 values for some near-shore and off-shore sea-water samples collected between Bombay and Ratnagiri. The four near-shore stations (along the 10 fathom line) SH-1, SH-2, SH-3, SH-4 show nearly uniform values for cesium-137 and are markedly low from off-shore values, possibly due to the influence of land drainage. The large variations in the off-shore values are

similar to those observed by Folsom *et al.*<sup>7</sup> off the California coast.

TABLE II

Cesium-137 and strontium-90 in surface sea-water off the West Coast of India (1963-64)

Sl. No.	Location*	Date of collection	Cesium-137 pC/100 l.	Strontium-90 pC/100 l.	Cs.137 Sr.90
1	Ratnagiri ..	6-12-1963	42±2†	12.0±2.0†	3.5
2	" ..	27-2-1964	25±2	7.0±1.0	3.5
3	" ..	4-3-1964	38±1	7.0±1.0	5.5
4	Mangalore	11-1-1964	26±2	15.0±2.0	1.8
5	" ..	23-3-1964	14±2	7.0±1.0	2.0
6	" ..	30-3-1964	19±1	3.4±1.0	5.6
7	Cochin ..	25-1-1964	30±1	37.0±0.5	0.8
8	Veraval ..	2-3-1964	19±2	9.0±1.0	2.2
9	" ..	2-3-1964	14±2	7.0±1.0	2.0
10	" ..	2-3-1964	15±2	6.0±1.0	2.5

* Veraval	20° 54' N	70° 22' E
Ratnagiri	17° 00' N	73° 15' E
Mangalore	12° 51' N	74° 50' E
Cochin	09° 58' N	76° 16' E

† One standard deviation on the basis of counting statistics sample volume 60 litres, reagent blanks (for 60 litres samples) Cesium-137=0.8 pC, Strontium-90=0.4 pC.

TABLE III

Cesium-137 in surface sea-water samples collected along the West Coast of India from Bombay to Ratnagiri (Nov.-Dec. 1964)

Sl. No.	Position	Cesium-137 pC/100 l.
AN-1	Bombay Harbour (Floating Light Vessel)	28 ± 0.6*
J-1	18° 41' N 72° 30' E	29 ± 0.6
J-2	18° 39' N 72° 18' E	12 ± 0.3
J-3	18° 34' N 72° 12' E	4 ± 0.3
J-4	18° 23' N 71° 47' E	9 ± 0.2
J-5	17° 56' N 71° 59' E	23 ± 0.5
J-6	17° 42' N 72° 07' E	16 ± 0.3
J-7	17° 24' N 72° 20' E	45 ± 0.9
J-9	17° 19' N 72° 29' E	18 ± 0.4
J-15	16° 38' N 72° 13.5' E	50 ± 1.0
SH-1	18° 26.5' N 72° 37.5' E	16 ± 0.3
SH-2	17° 58.5' N 72° 10' E	18 ± 0.4
SH-3	17° 32' N 72° 86.5' E	15 ± 0.3
SH-4	17° 06.5' N 73° 08' E	14 ± 0.3

\* One standard deviation on the basis of counting statistics sample volume 120 litres.

Studies on the distribution of cesium-137 and strontium-90 in coastal waters are being continued. A simplified procedure for the estimation of strontium-90 in sea-water has already been developed<sup>23</sup> and work is in progress for the rapid determination of fallout in sea-water.

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1. Bowen, V. T. and Sugihara, T. T., *J. Mar. Res.*, 1965, **23**, 123.
2. Rocco, G. G. and Broecker, W. S., *J. Geophys. Res.*, 1963, **68**, 4501.
3. Popov, N. I., Patin, S. A., Polevoi, R. I. and Konnov, V. A., *Okeanologiya*, 1964, **4**, 1026.
4. Folsom, T. R., Mohanrao, G. J. and Winchel, P., *Nature*, London, 1960, **187**, 480.
5. Miyake, Y., Saruhashi, K. and Katsuragi, Y., *Fag. Meteorol. Geophys.*, 1960, **11**, 188.
6. —, —, and Kamazawa, T., *J. Radiation, Res. (Japan)*, 1962, **3**, 141.
7. Folsom, T. R., Mohanrao, G. J., Pillai, K. C. and Sreekumaran, C., *U.S. Atom. Energy Comm. Rep. H.A.S.L.* 197, 1968.
8. Alexander, L. T., Jordan, R. H., Denver, R. F., Hardy, E. P. Jr., Hamada, G. H., Machta, L. and List, R. J., *U.S. Atom. Energy Comm. Rep. T.I.D.* 6567, 1960.
9. Hardy, E. P. Jr., List, R. J., Machta, L., Alexander, L. T., Allen, S. S. and Meyer, M. W., *U.S. Atom. Energy Comm. Rep. T.I.D.*, 17090, 1962.

10. Hardy, E. P. Jr., Rivera, J. and Collins, W. J. Jr., *U.S. Atom. Energy Comm. Rep. H.A.S.L.* 144, 1964.
11. Vochok, H. L., *U.S. Atom. Com. Rep. H.A.S.R.* 172, 1965.
12. Mauchline, J. and Templeton, W. L., *Oceanogr. Mar. Biol. Ann. Rev.*, 1964, **2**, 229.
13. Euntan, J. D., In *Chemical Oceanography* (Riley, J. P. and Skirrow, G., Eds.), Academic Press, London, 1965, **2**, 427.
14. Vijayakrishnan Nair, K., Bhattachari, P. M. A. and Chatterjee, B. F., *Bull. Atomic Research Centre, Bombay Rep. ASET-H-PM-8*, 1965.
15. Sugihara, T. T., James, H. I., Trolanillo, E. J. and Bowen, V. T., *Anal. Chem.*, 1959, **31**, 44.
16. Sunderman, D. N. and Townley, C. W., *Radiocemistry of Barium, Calcium and Strontium. Or-F of Tech. Serv. U.S. Bur. of Commerce NAS-NS 3619*, 1960.
17. Schroeder, B. W. and Cherry, R. D., *Nature*, London, 1962, **194**, 669.
18. Baranov, V. I., Vdovanko, V. M., Gedeonov, L. I., Ivanova, L. M., Kolesnikov, A. G., Popov, N. I., Khitrov, L. M. and Chaykov, P. M., *Proc. 3rd Int. Conf. Peaceful Use of Atom. Energy*, 1964, **14**, A/Conf. 25/P. 384.
19. Gallagher, J. F., *The Variability of Water Masses in the Indian Ocean*, Publ. Nat. Oceanogr. Data Centre (Washington D.C.), 1966, G. 11, 1-74.
20. Wooster, W. S., Schaffer, M. B. and Robinson, M. K., *Atlas of the Arabian Sea for Fishery Oceanography*, Inst. Mar. Res. Univ. of Calif., 1967, 67-12, 1-35 plates.
21. Lafond, E. C., In *The Encyclopedia of Oceanography* (Fairbridge, R. W. Ed.), Reinhold Publishing Corp., New York, 1966, p. 110.
22. Salo, A. and Voipio, A., In *Anomalous Concentration Fronts*, Proc. Int. Symp., Stockholm, Pergamon Press, Oxford and New York, 1966, p. 827.
23. Doshi, G. R. and Sreekumaran, C., *Chem. Sci.*, 1968, **37**, 554.

## FORMATION OF AN INTERMEDIATE PHASE IN ALUMINIUM-GERMANIUM SYSTEM

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### INTRODUCTION

THE interesting potentialities of the Duwez technique of rapidly quenching metals and alloys from the liquid state (also known as splat cooling or splat quenching) are now well recognized.<sup>1,2</sup> In addition to striking extension of terminal solid solubility limits in various binary systems, formation of several amorphous and new intermediate phases has been achieved, thanks to the spectacular cooling rates ( $10^5$ - $10^8$  deg. C. sec.) and consequent drastic undercooling associated with this technique.

We report here on the crystal structure of an aluminium-germanium (Al-Ge) phase produced by application of the Duwez technique. Under equilibrium conditions the Al-Ge system exhibits a eutectic at 30.3 at.% Ge and 424° C. Al is insoluble in Ge in the solid state, but dissolves a maximum of 2.8 at.% Ge at the eutectic temperature. Predecki *et al.*<sup>3</sup> reported extension of solid solubility of Ge in Al on splat cooling, without any indication of the actual increase in solubility. The formation of a complex and unidentified intermediate phase around the

eutectic composition was also briefly reported by them. The new phase identified by us in the present work was also obtained in an Al-30 at.% Ge alloy.

#### EXPERIMENTAL PROCEDURE

Weighed quantities of Al and Ge (both 99.99% pure) were melted in an evacuated fused silica capsule. The alloy was then homogenized for 15 hours at a temperature of 400°C.

The technique of liquid quenching has been reported earlier.<sup>4</sup> In the present work it mainly consisted of loading 50-100 mg. of the alloy in a resistance-heated graphite crucible with a nozzle at the bottom and heating to a temperature about 50°C. higher than the liquidus. The molten globule of the alloy was then expelled by means of a shock wave on to a copper substrate at room temperature. The splat-cooled products were thin foils of variable thickness (upto 15  $\mu$ m) and could be easily peeled from the substrate. They were examined in a Philips 114.6 mm. dia. camera with nickel-filtered Cu K $\alpha$  radiation ( $\lambda$ Cu K $\alpha$  = 1.54051 Å).

#### EXPERIMENTAL RESULTS

The Debye-Scherrer patterns consisted of weak Al reflections and no less than 35 other lines, none of which corresponded to Ge. Many of the extra lines were diffuse, the doublets being unresolved in case of high-angle reflections. All the reflections could, however, be satisfactorily indexed on the basis of a new phase with a tetragonal structure and with lattice parameters  $a = 13.03$  Å,  $c = 12.04$  Å and  $c/a = 0.924$  Å. Table I gives the relative intensities of the first 30 extra lines and the observed and calculated values of  $\sin^2\theta$ .

Deformation at room temperature did not transform the new phase, but only broadened the X-ray reflections further. All the lines due to the extra phase disappeared and gave way to the Al and Ge reflections after annealing at 300°C. for 30 minutes.

#### DISCUSSION OF RESULTS

The present study has shown that a new intermediate phase in the Al-Ge system can be produced by quenching the molten eutectic alloy to room temperature. The earlier investigators<sup>3</sup> reported the formation of a new phase only when the substrate was maintained at liquid nitrogen temperature.

TABLE I

Observed and calculated  $\sin^2\theta$  values of the metastable phase in aluminium-30 at.% germanium alloy

Structure: TETRAGONAL  
Lattice parameter:  $a = 13.03$  Å  $\approx \sqrt{10} a_{\text{FCC}}$   
 $c = 12.04$  Å  $\approx 3 a_{\text{FCC}}$   
 $c/a = 0.924$

$hkl$	$\sin^2\theta_{\text{calc.}}$	$\sin^2\theta_{\text{obs.}}$	$I_{\text{obs.}}$
220	0.0280	0.0296	vw
030	0.0315	0.0317	vw
113	0.0439	0.0442	ms
230	0.0455	0.0462	vwv
032	0.0475	0.0479	vwv
023	0.0509	0.0518	vwv
040	0.0560	0.0557	vw
330	0.0630	0.0632	vw
004	0.0656	0.0658	w
240	0.0700	0.0700	vw
133	0.0719	0.0718	w
042	0.0824	0.0819	w
242	0.0864	0.0858	s
152	0.1074	0.1075	vw
161	0.1336	0.1322	w
006	0.1476	0.1487	vw
116	0.1546	0.1549	ms
045	0.1585	0.1598	ms
163	0.1664	0.1688	vw
245	0.1725	0.1728	vw
271	0.1896	0.1890	vwv
236	0.1931	0.1925	vwv
336	0.2116	0.2121	vwv
246	0.2176	0.2168	w
047	0.2569	0.2576	vwv
090	0.2835	0.2833	vwv
257	0.3024	0.3014	vwv
048	0.3184	0.3176	vwv
067	0.3271	0.3274	vw
00.10	0.4100	0.4115	vwv

s=strong; ms=medium strong; w=weak;  
vw=very weak; vwv=very very weak.

The new metastable phase has been shown to be based on a rather large tetragonal unit cell. Such large unit cells are not uncommon in splat-cooled products. In the Au-21 at.% Ge alloy, a large tetragonal unit cell containing 176 atoms per unit cell<sup>5</sup> and in Au-25-50 at.% Si alloys an f.c.c. unit cell containing 500 atoms per unit cell<sup>6</sup> have been reported earlier.

The tetragonal unit cell of the new Al-Ge phase can be conceived of as forming from 30 unit cells of f.c.c. Al as shown in Fig. 1. The face diagonal of the rectangle formed by stacking three f.c.c. unit cells may be visualized as forming the 'a' parameter of the tetragonal unit cell (i.e.,  $a_{\text{Te}} = \sqrt{10} a_{\text{FCC}}$ ). The 'c' parameter corresponds to almost exactly 3 times the lattice parameter of the f.c.c. unit cell ( $a_{\text{Al}} = 4.049$  Å). The suggestion that

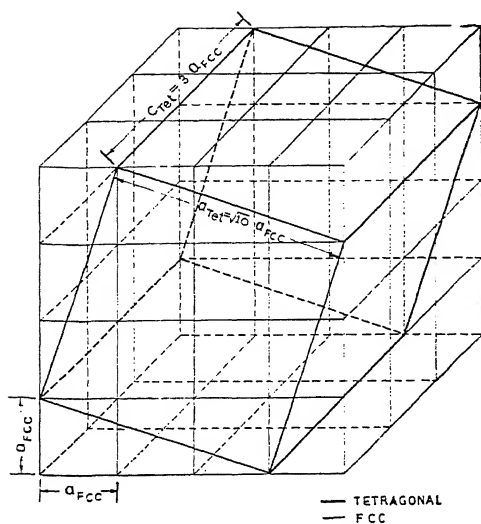


FIG. 1. Formation of the large tetragonal unit cell of the new Al-Ge phase with  $a_{\text{Tet}} \approx 1.10 a_{\text{FCC}}$  and  $c_{\text{Tet}} \approx 3 a_{\text{FCC}}$  from 30 unit cells of Al.

the tetragonal unit cell is formed by the stacking of three f.c.c. unit cells in all the three directions receives some support from the frequent occurrence of the number 3 or its multiples in indices ( $hkl$ ) of the X-ray reflections from the new phase (Table I). Assuming 120 atoms per unit cell on the basis of the same close packing as in the f.c.c. structure the atomic volume works out to  $17.03 \text{ \AA}^3$  from the dimensions of the tetragonal cell. This value is almost identical with the extrapolated atomic volume ( $17.02 \text{ \AA}^3$ ) for the Al-30 at.% Ge alloy<sup>7</sup> and further strengthens the suggested model for the unit cell of the new phase.

1. Anantharaman, T. R. and Ramachandra Rao, P., *Eastern Metals Review*, 1968, 19, 141.
2. Pol Duwez, *ASM Trans. Q.*, 1967, 60, 607.
3. Predecki, P., Giessen, B. C. and Grant, N. J., *Trans. TMS-AIME*, 1965, 233, 1438.
4. Pol Duwez and Willens, R. H., *Ibid.*, 1963, 227, 362.
5. Anantharaman, T. R., Luo, H. L. and Klement, W. Jr., *Ibid.*, 1965, 233, 2014.
6. Luo, H. L., Klement, W. Jr. and Anantharaman, T. R., *Trans. Ind. Inst. Metals*, 1965, 18, 214.
7. Rudman, P. S., *Trans. TMS-AIME*, 1965, 233, 864.

## SOME PRESSURE OSCILLATIONS OBSERVED IN INDIA AND THEIR PROBABLE ASSOCIATION WITH THE CHINESE NUCLEAR TEST 1965

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### INTRODUCTION

**W**ELL-MARKED oscillations extending for more than four hours were observed in the microbarograph records on 15th May, 1965 at Okha ( $22^\circ 29' \text{N}$ ,  $69^\circ 07' \text{E}$ ) in Gujarat State. Some stations north of latitude  $18^\circ \text{N}$ . showed abrupt changes in the barograph traces as late as on 20th May, 1965. These suggested the possibility of propagation of pressure waves in the Indian latitudes as a result of the Chinese nuclear test during this period and led to detailed examination of the records of many stations in the neighbourhood. Figure 1 shows the stations whose barograph records were examined and which recorded significant impulses.

### 'ROUND-THE-WORLD' WAVES

Authentic reports about the exact time of explosion are not available. According to a special report<sup>1</sup> by Edward Neilan, the second blast was detonated at Lop Nor on 13th May, 1965, the actual time of explosion being not

mentioned. Pressure waves can exist for long period without absorption and therefore it is not unlikely that the above pressure fluctuations recorded in India resulted from this explosion.

After the Russian nuclear tests at Novaya Zemlya in October, 1961, special observations at the Atomic Weapons Research Establishment, Essex,<sup>2</sup> with high sensitivity barographs showed clear signals of large amplitude 76 hours after the explosion. This was attributed to the waves being successively reflected at the antipodes with relatively little absorption or scattering. Similar studies at Sodankyla, Finland<sup>3</sup> after the same explosion showed microbarograph deflection 38 hours later and these were interpreted as due to "round-the-world waves" both in the forward and backward direction with mean velocity of 311 metres/sec. It was therefore considered worthwhile to examine the traces in the present case in order to see if the fluctuations were due to direct or 'round-the-world' waves after the Chinese explosion.

## BAROGRAPH OSCILLATIONS

After eliminating the cases where the abrupt changes of trace can possibly be associated with weather phenomena or short marks, there were fifteen cases when the barographs recorded impulses which might have been caused by

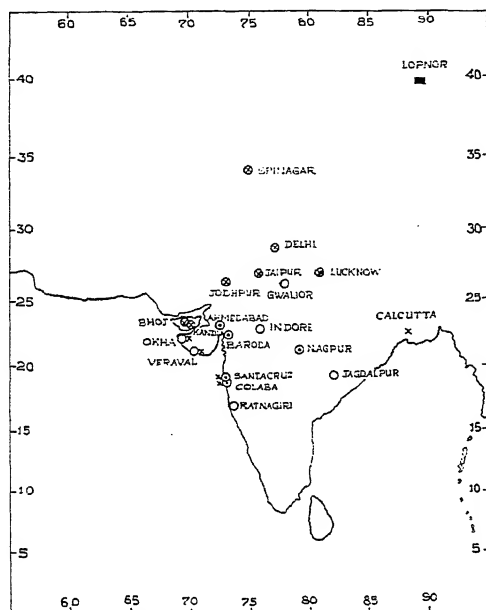


FIG. 1. O Barograms showed impulses due to direct or "Round-the-World Wave". X Barograms showed impulses which could be associated weather phenomena, short marks, etc. X Barograms whose impulses could not be interpreted. O Barograms examined but did not show any abnormal features.

pressure waves (Figs. 2 and 3). These impulses were mostly well-marked oscillations, but in some cases they were kinks in the trace accompanied by significant pressure rise or fall. Similar faint traces have been observed in the pressure records after the test explosion over Japan. It was possible in ten of these cases, to explain the impulses as due to the arrival of the direct or "round-the-world" pressure waves. Details of these are given in Table I, together with the copies of the traces in Fig. 2. The velocity of propagation of the waves was calculated on the assumption that the explosion took place on the early morning of the 14th May, 1965, and the direct wave affected Nagpur on 14th May at 0355 IST (Fig. 2). The velocity of the waves varied in each case, the maximum and minimum values being 328 and 303 m/s. respectively. These figures are in agreement with the similar computation of velocities for the direct wave recorded at a number of stations in India, viz., 304–322 m/s. after the Russian test explosion.<sup>4</sup> Minimum velocities of the order of 285–307 m/s. have been reported<sup>5</sup> in the case of waves from Hydrogen Bomb explosion over Japan. On the basis of these data, the actual time of the Chinese explosion is derived as 2023 GMT of 13th (0153 IST/14th) which is in agreement with the special report of the explosion mentioned earlier. A few of the press reports suggest a time of explosion of 0200 GMT/14th (1000 hrs. Peking time). This, however, appears doubtful since attempts to explain the arrival of direct waves or round-the-world

TABLE I

Sl. No.	Station	Lat. °N.	Long. °E.	Distance from LOPNOR in km.	Date and time (in GMT) of arrival of wave	Velocity m/s.	Maximum amplitude mb. (approx.)	Type of wave*
1	Nagpur	.. 2109	7907	2300	13 2225	318.9	0.7	Direct
2	Okha	.. 2229	6907	2740	15 0445	320.2	1.3	1st round-the-world in backward direction
3	Colaba	.. 1854	7249	2770	16 1425	324.8	0.5	2nd round-the-world in backward direction
4	Santacruz	.. 1906	7251	2750	16 1432	324.7	1.0	do.
5	Ahmedabad	.. 2302	7235	2460	16 1753	329.6	0.7	2nd round-the-world forward wave
6	Veraval	.. 2054	7022	2770	16 2145	313.4	0.8	do.
7	Baroda	.. 2218	7315	2500	16 2355	302.8	0.5	do.
8	Ahmedabad	.. 2302	7235	2460	19 1350	313.3	1.4	3rd round-the-world in forward direction
9	Baroda	.. 2218	7315	2500	19 1711	320.6	0.8	4th round-the-world in backward direction
10	Veraval	.. 2054	7022	2770	19 1930	315.8	0.5	do.

\* Forward wave is assumed as the one travelling southwards from Lopnur to India whereas the wave moving in the opposite direction is taken as the backward wave.



waves made on the assumption that the explosion took place at 02 GMT/14th lead to abnormal velocities of the order of 350–400 m/s. in many cases.

undertaken. Even so the limited information available and the internal consistency that apparently exists between the ten cases cited

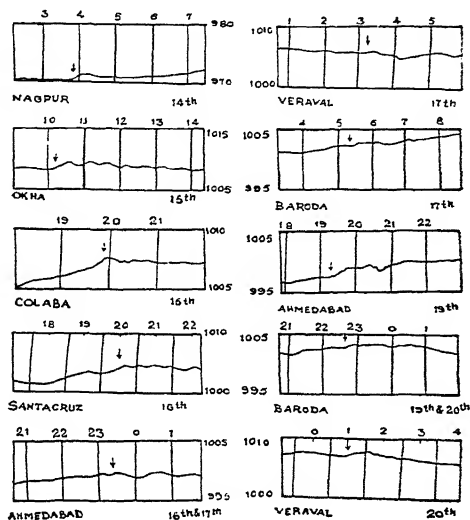


FIG. 2. Barograms showing impulses due to direct and round-the-world waves. Time of records in IST.

In the present examination, very high accuracy is not claimed on account of the fact that the clocks at different stations had not been exactly synchronised. The sensitivity of the instruments at different stations may not also be very high. To some extent, the non-registration of the impulses at some of the stations located nearer the site of explosion might have been due to the low sensitivity of the barographs there. While the impulses registered at the stations can be attributed to successive 'round-the-world' waves, these stations have not been affected by the direct waves except in the case of Nagpur. Further, the direct wave or 'round-the-world' waves could not explain a few remaining cases of impulses recorded on the barographs during this period (Fig. 3). It is likely that the large mountain barrier, viz., the Himalayan ranges lying between the test site and these stations have damped the direct pressure waves in some unknown manner. Comparatively lesser orographic features off the coast of Japan have caused a decrease in the amplitude of the waves after the Hydrogen Bomb blasts.<sup>5</sup> It is necessary to obtain more precise data regarding the time, nature and intensity of explosion before any detailed analysis of the wave propagation caused by this explosion can be

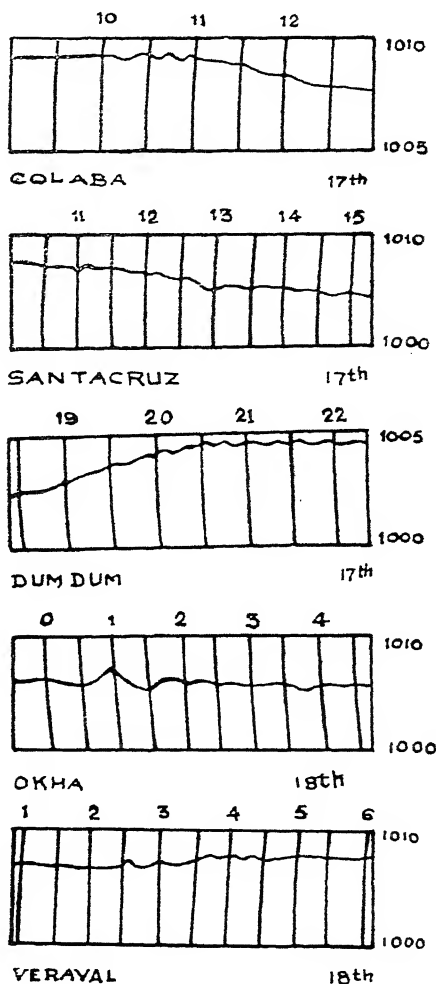


FIG. 3. Unexplained wave patterns.

strongly suggest that direct as well as 'round-the-world' pressure waves following the Chinese nuclear explosion are responsible for the observed impulses on the microbarograms over India.

#### ACKNOWLEDGEMENT

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1. Edward Neilan, *The Sunday Standard*, Bombay Edition, 4th July 1965.

2. Carpenter, E. W., Harwood, G. and Whiteside, T., *Nature*, 1961, 192 (4805), 857.
3. Rose, G., Oksman, J. and Kataja E., *Nature*, 1961, No. 4808, p. 1173.
4. Rao, K. V. and Ananthakrishnan, R., *Ind. Jour. Met. Geoph.*, July 1962, 13, 333.
5. Japan Society for the Promotion of Science, Tokyo, *Research in the Effect and Influences of the Nuclear*

*Bomb Test Explosion*, 1955, 1, 1 to 7 & 91 to 115.  
 (i) "Effect of atomic explosion on the atmosphere and sea," by Yasuo Miyate. (ii) "The microbarograph oscillations produced by explosion of H<sub>2</sub> bomb," by R. Yamamoto. (iii) "Preliminary report on the atmospheric pressure oscillations due to H bomb explosion."

## EFFICIENCY OF ENERGY CAPTURE BY THE GRASSLAND VEGETATION AT VARANASI

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WITH the growing interest in recent years on the evaluation of productivity in various natural and man-modified ecosystems, much emphasis has been laid on the efficiency with which the energy is trapped, accumulated and dissipated at different trophic levels. The first step in the process of energy flow within an ecosystem is the capture of solar energy by green plants. The productivity potential of different ecosystems depends much on the efficiency with which the vegetation accumulates this energy in the net primary production. Although data on energy relations of a number of temperate ecosystems have been published,<sup>1-4</sup> so far no information is available regarding the terrestrial systems in India.

The present study was conducted with three types of grasslands situated within the campus of the Banaras Hindu University (25° 20' N. latitude 83° 1' E. longitude). These grasslands are graded according to the intensity of herbage removal as least disturbed, moderately disturbed and over disturbed.<sup>5</sup> Net aboveground community production was evaluated through monthly harvests and by summing up the positive differences in the plant biomass in different periods.<sup>7</sup> Underground plant biomass was evaluated through monoliths and net production was computed by the difference method.<sup>8</sup> Energy content of the aboveground and underground plant material was estimated with the help of a Bomb calorimeter during June 1968.<sup>9</sup> The calorific values were calculated on the basis of ash-free dry weight in order to avoid the variation between organic samples of various types and the error due to pollution with dense, non-combustible materials as argued by Ovington and Lawrence.<sup>5</sup>

The energy content varies from 4018.8 to 4336.6 gram cal./g. ash-free dry weight in the aboveground parts of the herbage and from 4528.1 to 4770.4 g.cal./g. in the underground parts. The average values based on six samples

of aboveground herbage and three samples of underground plant material come to 4150.23 g.cal./g. and 4648.06 g.cal./g. respectively. Ovington and Lawrence<sup>5</sup> have reported the following calorific values for maize field, prairie, savanna, and oakwood ecosystems in Minnesota: 4525, 4827, 4817 and 4865 g.cal./g. respectively. Thus, the energy content in the herbage of our grasslands seems to be a little lower than that of temperate vegetation. In alpine plants, Hadley and Bliss<sup>10</sup> have reported higher calorific values for shoots (4557-5648 g.cal./g.) as compared to underground parts (4405-4996 g.cal./g.). In our grasslands the situation is reverse.

On the basis of the calorific values and the net dry matter production, the net primary community production in different grasslands has been computed in terms of energy and the values for the same are set in Table I. From Table I it is apparent that most of the net annual energy accumulation is accrued during the period 23rd June to 30th September, which, therefore, constitutes the grand period of growth. The new underground growth during post-monsoon period could not be measured because it is very meagre as compared to the decomposition and disappearance of the carry over from the monsoon period. Evidently, therefore, more thorough sampling gadgets and procedure have to be used in future studies.

The amounts of energy in the primary net production when expressed as percentages of half of the total solar radiation received during the period represent the efficiency of energy capture. Here only half of the incident radiation is considered because approximately 50% of the total radiation (that in the ultra-violet and infra-red portions of the spectrum) is not usable by plants in photosynthesis.<sup>11-12</sup> No data on incident solar radiation are available at Varanasi, but at Allahabad, which is situated very near to this area on almost the

TABLE I  
Net primary production in the grasslands at Varanasi in terms of energy  
(kg.cal./m<sup>2</sup>)

Grasslands	Aboveground		Underground		Total annual net production	
	June-September	Total annual	June-September	Total annual	June-September	Total annual
Least disturbed ..	1449.72	1798.30	1436.11	1436.11	2885.83	3234.41
Moderately disturbed ..	1822.78	2105.41	1193.39	1193.39	3016.17	3298.80
Over disturbed ..	1958.91	2139.44	990.96	990.96	2949.87	3130.40

TABLE II  
Efficiency of energy capture as percent half total solar incident radiation

Grasslands	Aboveground		Underground		Total annual net production	
	June-September	Total annual	June-September	Total annual	June-September	Total annual
Least disturbed ..	0.82	0.19	0.81	0.15	1.63	0.34
Moderately disturbed ..	1.03	0.22	0.67	0.12	1.71	0.35
Over disturbed ..	1.11	0.23	0.56	0.10	1.67	0.33

same latitude, 511 g.cal./cm.<sup>2</sup>/day have been recorded as average incident solar energy. Thus, total incident solar radiation for the year comes to 1865150 kg.cal./m.<sup>2</sup> and that for the grand growth period (23rd June to 30th September) 352590 kg.cal./m.<sup>2</sup>. The data for the efficiency of energy capture based on 50% of these values are set in Table II.

It is apparent from Table II that the progressive disturbance increases the net production and efficiency of aboveground parts and decreases these for the underground parts. It implies, therefore, that in comparatively protected fields energy is stored in the underground parts with greater efficiency, while with increasing disturbance more energy is accumulated in aboveground parts. The efficiency is more than five times greater during June-September as compared to the average efficiency for the whole year. When the total net production (aboveground + underground) is considered the differences in the efficiency due to variable intensity of disturbance become meagre. The results indicate that even during the grand growth period only 1.63-1.71% of the usable solar insolation is accumulated by the vegetation.

Ovington and Lawrence<sup>5</sup> have reported the efficiency of energy capture by the maize field, their most productive ecosystem, to be 0.94% for the growing period of 92 days and 0.35% for the whole year. Evidently, they have considered total incident solar radiation. Based on the same type of consideration average efficiency for our grasslands would be 0.83%

and 0.17% respectively for the grand growth period and for the whole year. For an old-field Broomsedge Community at South Carolina this efficiency is reported by Golley<sup>4</sup> to be 0.3-0.4%. But instead of net production he has considered gross production and hence no direct comparison can be made.

Based on the average annual input of solar radiation and dry matter yield of cereals, Penman<sup>13</sup> has recently estimated this efficiency for certain tropical countries including India to range between 0.02 and 0.04%.

We are thankful to Dr. V. B. Chowdhary and other participants of the Summer Institute in Ecology for helping through the determination of energy content.

1. Billings, W. D., *Plants and the Ecosystem*, MacMillan and Co. Ltd., London, 1964.
2. Odum, E. P., *Ecology*, Holt, Rinehart and Winston, Inc., 1963.
3. Golley, F. B., *Ecol. Monogr.*, 1960, **30**, 187.
4. —, *Ibid.*, 1965, **35**, 113.
5. Ovington, J. D. and Lawrence, D. B., *Ecology*, 1967, **48**, 515.
6. Phillipson, J., *Ecological Energetics*, Edward Arnold Ltd., 1968.
7. Singh, J. S., In *Proc. of Samp. on Recent Advances in Tropical Ecology*, Ed. R. Misra, Varanasi, 1967.
8. Dahlman, R. C. and Kucera, C. L., *Ecology*, 1965, **46**, 84.
9. Summer Institute in Ecology, *Grassland Ecosystem*, Dept. of Bombay, B.H.U., 1968.
10. Hadley, E. B. and Bliss, L. C., *Ecol. Monogr.*, 1964, **34**, 331.
11. Daubenmire, R. F., *Plants and Environment*, J. C. Wiley Co., New York, 1947.
12. Terrien, J., Truffaut, G. and Carles, J., *Light, Vegetation and Chlorophyll*, Philosoph. Libr., New York, 1957.
13. Penman, H. L., *Science Jour.*, 1968, **4**, 43.

## LETTERS TO THE EDITOR

DICHROMATIC SHUBNIKOV  
SPACE GROUPS

THE distinct magnetic variants of the crystallographic point groups are constructed from the non-equivalent alternating representations of the point groups.<sup>1-4</sup> Analogously it has been suggested<sup>1-5</sup> that the dichromatic Shubnikov space groups can also be obtained from the alternating representations of the conventional space groups. But it is well known that the character table of the space group  $Fd3m$  ( $O_h^7$ ) contains only four real one-dimensional irreducible representations including the total symmetric class.<sup>5-7</sup> Further it was already shown by the authors<sup>4</sup> that the total symmetric representation of a group  $G$  induces  $G$  itself, whereas its non-equivalent real one-dimensional (alternating) representations induce the different magnetic variants of  $G$ . Thus one gets only three magnetic variants of the space group  $Fd3m$ . But from the celebrated works of Belov, Neronova and Smirnova,<sup>8</sup> Zamorzaev<sup>9</sup> and Opechowski and Guccione,<sup>10</sup> it is evident that the four dichromatic Shubnikov space groups  $Fd'3m$ ,  $Fd'3m'$ ,  $Fd'3m''$  and  $F_d3m$  are associated with the space group  $Fd3m$ . In this context, one is prompted to pose the question, namely, how can one obtain the four dichromatic Shubnikov space groups from the three alternating representations of the space group  $Fd3m$ ? So it is clear that the magnetic variants of a crystallographic space group may not, in general, be obtained from its alternating representations. Apparently one is led to conclude that an approach similar to the one adopted in the case of the derivation of the double-coloured point groups does not necessarily hold good in the enumeration of the magnetic space groups. This anomaly of obtaining the dichromatic magnetic space groups of the space group  $Fd3m$  from the representation theory will be clarified and explained in this note.

The symmetry operations of a space group consist of pure translations, rotations, rotation-reflections, screw axes and glide planes. It is well known<sup>11</sup> that the irreducible representations of a space group can be associated with the wave vectors of the reciprocal space. That is to say, the magnetic variants of a space group are induced not by the alternating representations of the space group but

by those of the space group which is reciprocal to the given space group. This view is in complete agreement with the mode of construction of the character tables of space groups.<sup>6,12</sup> Further this is also in conformity with the connection of the double-coloured magnetic Bravais lattices to the stars of the wave vectors contained in the symmorphically reciprocal space groups<sup>13</sup> and in agreement with the general suggestion of investigating systematically the symmetries of the reciprocal space.<sup>14</sup>

The underlying point space group (or symmorphically space group) is obtained by equating the fractional translations present in the screw axes and the glide planes of the given space group to zero. A space group which is free from screws and glides coincides with its underlying symmorphically space group. The various irreducible representations of a space group are associated with the wave vectors contained in the stars of the symmorphically space group which is reciprocal to the underlying point space group.<sup>6</sup> For instance, the underlying symmorphically space group of  $Fd3m$  is  $Fm3m$  ( $O_h^5$ ) and its reciprocal space group is  $Im3m$  ( $O_h^6$ ) (*International Tables for X-ray Crystallography*, pages 338 and 344, 1952). Further it is well known that if a crystal lattice is primitive or side-centred, its reciprocal lattice will also be primitive or side-centred, whereas if it is face-centred its reciprocal lattice is body-centred and *vice versa*.

In the construction of the magnetic variants of the space groups of any system, it is sufficient<sup>4</sup> if the basic translations  $T_x$ ,  $T_y$  and  $T_z$  along the Bravais axes are so chosen that they satisfy the relations  $T_x^2 = T_y^2 = T_z^2 = E$  (identity element). But  $T_x$ ,  $T_y$  and  $T_z$  can be respectively represented (Koster<sup>11</sup>) by  $\exp(2\pi i k_x)$ ,  $\exp(2\pi i k_y)$ , and  $\exp(2\pi i k_z)$ , where  $k_x$ ,  $k_y$  and  $k_z$  are the components of

the wave vector  $\vec{k}$  belonging to the reciprocal space. In the case of the cubic system, since  $T_x$ ,  $T_y$  and  $T_z$  are equal in magnitude, it follows that  $k_x = k_y = k_z = 0$  or  $\frac{1}{2}$ . Hence in the derivation of the Shubnikov dichromatic space groups of the cubic system, only the wave vectors  $(0, 0, 0)$  and  $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$  need be considered.

The symmorphic space groups  $P2_3$ ,  $F2_3$ ,  $I2_3$ ,  $Pm3$ ,  $Fm3$ ,  $Im3$ ,  $P432$ ,  $F432$ ,  $I432$ ,  $P\bar{4}3m$ ,  $P\bar{4}3m$ ,  $I\bar{4}3m$ ,  $Pm3m$ ,  $Fm3m$  and  $Im3m$  are the distinct required reciprocal point space groups in terms of whose alternating representations, the Shubnikov dichromatic space groups corresponding to the 36 conventional cubic space groups can be enumerated and described. This means that the alternating representations of all the 36 cubic space groups are not necessary for the enumeration of the dichromatic magnetic space groups of the cubic system. This is not exclusively true for the cubic system alone but is found to be valid for the construction of the Shubnikov space groups of other systems also.

From these considerations it follows that the magnetic variants of the space group  $Fd3m$  can be obtained from the non-equivalent alternating representations of the space group  $Im3m$ . The 8 real one-dimensional representations present in the character table of  $Im3m$  are associated<sup>6,12</sup> with the stars  $a$  (0, 0, 0) and  $b$  ( $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ) of the space group  $Fm3m$ . Taking equivalence among the inducing alternating representations of  $Im3m$ , the four magnetic variants of the space group  $Fd3m$  can be easily visualised. It may also be noted that the three alternating representations of  $Im3m$  in which  $T_x$ ,  $T_y$  and  $T_z$  are represented by the character +1 and which are associated with the star  $a$  (0, 0, 0) induce the variants  $Fd'3m$ ,  $Fd3m'$  and  $Fd'3m'$ . The magnetic space group  $F_d3m$  is induced by any one of the 4 alternating representations of  $Im3m$  which correspond to the star  $b$  ( $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ) and which can be shown to be equivalent. Though the cubic face-centred Bravais lattice does not possess a magnetic variant, yet  $F_d3m$  is associated with the star  $b$  ( $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ) of the space group  $Fm3m$ . The star  $b$  ( $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ) of  $Fm3m$  has already been shown<sup>13</sup> to be related to the magnetic variant of the cubic body-centred lattice. This method of deriving the magnetic variants of a space group from the alternating representations of the symmorphic reciprocal space group can be easily applied and extended for the derivation of the magnetic variants of the other space groups of the cubic system. From the alternating representations of a symmorphic space group which is reciprocal to itself, the associated dichromatic Shubnikov space groups can be straight away obtained. This is a general method which is applicable to the construction of the Shubnikov dichromatic space groups of

other systems. Details regarding the derivation of the 77 cubic dichromatic Shubnikov space groups and some general interesting features encountered in the construction of the magnetic variants of the space groups of other systems will be published elsewhere.

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Andhra University, T. S. G. KRISHNAMURTY.  
Waltair, P. GOPALAKRISHNAMURTY.  
July 16, 1968.

1. Indenbom, V. L., *Soviet Physics Crystall.*, 1959, 4, 578.
2. Niggli, A., *Z. Krist.*, 1959, 111, 288.
3. Bertaut, E. F., *Acta Cryst.*, 1968, A24, 217.
4. Krishnamurty, T. S. G. and Gopalakrishnamurty, P., (in press).
5. Bhagavantam, S. and Venkatarayadu, T., *Theory of Groups and its Application to Physical Problems*, Andhra University, 1951, p. 157.
6. Raghavacharyulu, I. V. V., *Ph.D. Thesis*, Andhra University, 1963.
7. Gopalakrishnamurty, P., Unpublished work, 1960.
8. Belov, N. V., Neronova, N. N. and Smirnova, T. S., *Soviet Phys. Cryst.*, 1957, 2(3), 311.
9. Zamorzaev, A. M., *Ibid.*, 1957, 2(1), 10.
10. Opechowski, W. and Guccione, R., *Magnetism*, Academic Press, Oxford, 1965, 2 A, 105.
11. Koster, G. F., *Solid State Physics*, Academic Press, 1957, 5, 173.
12. Raghavacharyulu, I. V. V., *Can. Jour. Phys.*, 1961, 39, 830.
13. Krishnamurty, T. S. G. and Gopalakrishnamurty, P., *Curr. Sci.*, 1968, 37, 574.
14. Beinenstock, A. and Ewald, P. P., *Acta Cryst.*, 1962, 15, 1253.

#### NOTE ON K-SHELL INTERNAL CONVERSION COEFFICIENT OF THE 279 keV TRANSITION IN $Tl^{203}$

THE internal conversion coefficients of the  $l$ -forbidden  $M_1$  transitions in odd  $Z$  nuclei have been a subject of interest in the last few years. These transitions are expected to exhibit nuclear penetration effects.<sup>1</sup> The K-conversion coefficients of the 279 keV gamma-ray of  $Tl^{203}$  from the beta decay of  $Hg^{203}$  have been measured by several authors using different techniques. The values using scintillation technique are slightly higher than those obtained by beta-ray spectrometer. We have remeasured the K-shell internal conversion coefficient ' $\alpha_K$ ' for this transition using scintillation technique to estimate the nuclear penetration effects.

The  $Hg^{203}$  source was prepared in a perspex cell of 2 mm. internal diameter. The single gamma-ray spectrum was taken with a scintillation spectrometer consisting of NaI (Tl)

crystal of 5.1 cm. height and 4.4 cm. diameter. The resolution of the spectrometer was 9% for the 662 keV gamma-ray of  $\text{Cs}^{137}$ . To measure the K-conversion coefficient of the 279 keV gamma-ray, the areas under the K-X-ray peak and the photo-peak of 279 keV gamma-ray were measured after applying various corrections.

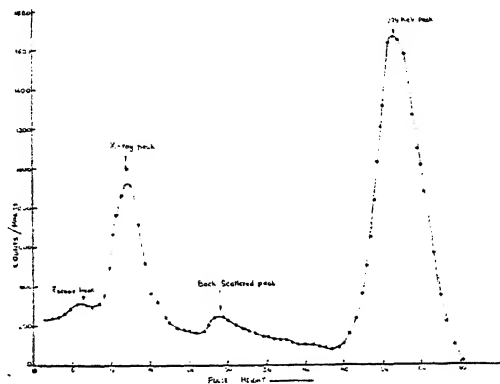


FIG. 1. The  $\gamma$ -spectrum of  $\text{Hg}^{203}$  taken by a NaI (Tl) scintillator placed at a distance of 7 cm. from the source.

Correction was applied for the absorption of K-X-rays and  $\gamma$ -rays in the 0.81 mm. thick aluminium oxide and the 1.5 mm. thick aluminium can surrounding the crystal. The correction factor for the 70 keV X-ray was found to be 0.864 and that for the 279 keV gamma-ray 0.932. The escape peak correction was applied to the total number of counts under the K-X-ray photo-peak. The fraction of K-X-ray which gave rise to escape peak at this energy was found to be 10%. Knowing this factor, the total number of K-shell vacancies was obtained. The total number of counts due to K-X-ray as well as the 279 keV gamma-ray were determined with the help of photo to total area curve. The values of photo to total areas for the 70 keV X-ray and 279 keV gamma-ray are 1.00 and 0.84 respectively. The K-shell fluorescence yield factor  $W_K$  for  $\text{Tl}^{203}$  was taken to be 0.954.

After applying all these corrections the value of  $a_K$  was found equal to 0.179. The statistical error was of the order of 2%. The total errors in the value of  $a_K$  were estimated to about 7%. Thus:

$$a_K = 0.179 \pm 0.013$$

This value of  $a_K$  is in good agreement with other measurements, but slightly higher than the  $\beta$ -ray spectrometer values. The theoretical value of the conversion coefficient for  $M_1$

and  $E_2$  type of transition for 279 keV gamma-ray are 0.394 and 0.076 respectively. The measured value of  $a$  requires that the transition is mixed and this transition is retarded by a factor of about 1000 with respect to the single particle estimate.<sup>2</sup>

The nuclear penetration parameter  $\lambda$ , which is defined as the ratio of the magnitude of the penetration matrix element to the corresponding gamma-ray matrix element, ( $\lambda = M_e/M_r$ ) has been calculated from the present experimental results. For this transition the value of mixing ratio parameter<sup>2</sup>  $|\delta(E_2/M_1)|$  was taken to be  $\delta = 1.40 \pm 0.10$ . Using this value of  $\delta$ , the experimental  $M_1$  conversion coefficient was calculated, assuming the  $E_2$  part is ineffective in the penetration effect. The experimental  $M_1$  conversion coefficient was calculated by the relation

$$\beta_1(\text{exp}) = (1 + \delta^2)a_K(\text{exp}) - \delta^2 a_2(\text{Sliv}).$$

The value of  $\beta_1(\text{exp})$  came out to be  $0.377 \pm 0.016$  from the above expression. The values of the parameter  $\lambda$  were determined to be  $1.81 \pm 0.75$  and  $75.1 \pm 1.8$ .

The lower root corresponds to a negligible contribution of the penetration matrix element which cannot be accepted for the present transition. The upper root required that the penetration matrix element plays an important role. The disagreement between this value of  $\lambda$  and the earlier reported value<sup>3</sup> is about ten times.

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1. Church, E. L. and Wenesor, J., *Phys. Rev.*, 1956, **104**, 1382.
2. Deutsh, B. J. and Metzger, F. R., *Ibid.*, 1962, **122**, 848.
3. Gerholm, T. R. *et al.*, *Nuclear Physics*, 1965, **65**, 511.

### CORIOLIS COUPLING COEFFICIENTS OF HCOF AND DCOF

THE vibrational spectra of formylfluoride (HCOF) and *d*-formylfluoride (DCOF) molecules have been studied by Morgan and his associates.<sup>1</sup> These molecules possess  $C_s$  symmetry with  $5a_1 + 1a_2$  vibrations. The molecular parameters have been fixed by an electron diffraction study by Jones *et al.*<sup>2</sup> The infrared absorption spectra of HCOF and

DCOF have been observed by Stratton *et al.*<sup>3</sup> and a set of rotational constants has been reported by them. Potential constants and generalized mean square amplitudes of vibration have been evaluated for these molecules recently.<sup>4,5</sup> In this note we report their Coriolis coupling coefficients. The non-vanishing Coriolis constants for these molecules are of type  $\zeta_{ij}^x$  and  $\zeta_{ij}^z$  arising from the  $a_1 \times a_2$  coupling. After obtaining the force constant matrix elements and the Coriolis C elements, the zeta values are determined from the relation  $\zeta_{ij}^x = L^{-1} C_{ij}^x L^{-1}$ ,  $L^{-1}$  being the inverse of the normal co-ordinate transformation matrix. The results are presented in Table I and they are found to satisfy the square sum rule to a high degree of accuracy. The high magnitude of  $\zeta_{16}^x$  and  $\zeta_{56}^x$  indicate that these couplings are significant.

TABLE I

Coriolis coupling coefficients for HCOF and DCOF molecules

$\zeta_{ij}^x$	HCOF	DCOF	$\zeta_{ij}^z$	HCOF	DCOF
$\zeta_{16}^x$	0.8937	0.8982	$\zeta_{16}^z$	0.0002	0.0189
$\zeta_{26}^x$	-0.3063	-0.3090	$\zeta_{26}^z$	0.0763	0.3038
$\zeta_{36}^x$	-0.2420	-0.2093	$\zeta_{36}^z$	0.0867	-0.0959
$\zeta_{46}^x$	0.1559	0.3695	$\zeta_{46}^z$	-0.0579	-0.1750
$\zeta_{56}^x$	0.1704	0.0568	$\zeta_{56}^z$	0.9899	0.9311

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Alwaye-4, M. K. RUDRA WARRIER.  
August 7, 1968.

1. Morgan, H. W., Staats, P. A. and Goldstein, J. H., *J. Chem. Phys.*, 1956, **25**, 337.
2. Jones, M. E., Medberg, K. and Schomaker, V., *J. Amer. Chem. Soc.*, 1965, **77**, 5278.
3. Stratton, R. F. and Neilson, A. H., *J. Mol. Spect.*, 1960, **4**, 373.
4. Venkateswarlu, K., Jagatheesan, S. and Rajalakshmi, K. V., *Proc. Ind. Acad. Sci.*, 1963, **58**, 373.
5. — and Malathy Devi, V., *Ibid.*, 1965, **61**, 272.

# KINETICS OF OXIDATION OF 1,3-PROPANE DIOL BY PEROXY- DISULPHATE CATALYSED BY SILVER IONS

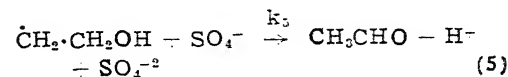
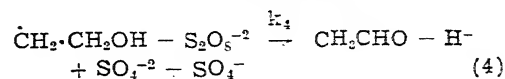
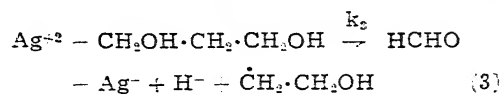
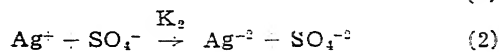
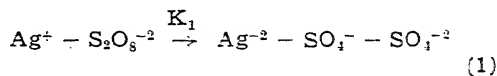
A SYSTEMATIC study of the oxidation of 1,2- and 1,3-diols was undertaken by the authors to investigate the role of silver ions as a catalyst. The present communication indicates the results of oxidation of 1,3-propane diol by peroxydisulphate catalysed by silver (I) ions.

The rate at which peroxydisulphate was consumed was estimated by the method of Bartlett and Cotman.<sup>1</sup> Typical runs indicated that the order with respect to  $S_2O_8^{2-}$  is one and that the rate is independent of concentration of 1,3-propane diol at 48.5°C. The increasing concentration of  $Ag^+$  ions ( $2.6 \times 10^{-4}$ — $13.0 \times 10^{-4}$  moles/litre) results in increased catalytic activity ( $K_1 = 1.66 \times 10^{-4}$ — $7.80 \times 10^{-4}$  sec.<sup>-1</sup>) and bears a linear relationship to rate constants.

The effect of  $H^+$  ion concentration was studied by the addition of sulphuric acid, at constant ionic strength maintained by potassium sulphate. Rate constant decreases appreciably up to  $H^+$  ion concentration of  $4.81 \times 10^{-2}$  moles litre<sup>-1</sup>, but remains constant at higher concentrations. The reaction was studied at different temperatures ranging from 32.4°C. to 50.2°C. for determination of various thermodynamical parameters.

In the oxidations by peroxydisulphate, both  $Ag(II)^+$  and  $Ag(III)^2$  are reported. However in the oxidation of 1,3-propane diol authors have postulated the mechanism based on the formation of reactive  $Ag^{+2}$  species, which also accords with the observation of Higgenison and Marshall.<sup>3</sup>

The following mechanistic steps are suggested:



On the basis of this mechanism

$$-\frac{d[S_2O_8^{2-}]}{dt} = K [Ag^+] [S_2O_8^{2-}]$$

where

$$K = k_1 + k_2 \left( \frac{k_1 k_2}{k_3 k_4} \right)^{\frac{1}{2}}$$

The energy of activation as calculated from the results at three temperatures was 18.2 K cal. mole<sup>-1</sup>. The frequency factor and the  $\Delta S$  calculated are  $5.36 \times 10^{12}$  l mole<sup>-1</sup> sec<sup>-1</sup> and +1.23 E.U. respectively. A standard value for comparison for bimolecular reactions is about -12. E.U. (Calculated for frequency factor  $10^{11}$ ), increase in entropy is expected if reactants are oppositely charged ions and hence slow step (2) is supported by a positive entropy change. A 1:1 Stoichiometry for  $\Delta S_2O_8^{2-}/\Delta$  1,3-propane diol was evaluated from 85% completed reactions by estimating  $S_2O_8^{2-}$  and corresponding 2:4, dinitrophenyl hydrazones. Thus proposed mechanism leads to the observed rate law and explains pronounced catalysing effect of  $Ag^-$  and dependence of the rate constant on the first power of the catalyst ion. Different from this Subbaraman and Santappa<sup>4</sup> found the oxidation of secondary and tertiary alcohols running proportional to  $[Ag^-]^{\frac{1}{2}}$ . Acetaldehyde and formaldehyde were mainly identified as products of oxidation along with traces of formic and acetic acid.

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Univ. of Udaipur (India), G. V. BAKORE.  
July 24, 1968.

1. Bartlett, P. D. and Cotman, J. D., *J. Amer. Chem. Soc.*, 1949, **71**, 1419.
2. Gupta, V. K. and Ghosh, S., *J. Inorg. Nuclear Chem.*, 1959, **1**, 178.
3. Higgenison, W. C. and Marshall, J. W., *J. Chem. Soc. (London)*, 1959, p. 447.
4. Subbaraman, L. R. and Santappa, M., *Z. Physik. Chem. Neue Folge*, 1966, **48**, 163.

### DISSOCIATION CONSTANTS OF 3,5-DINITROSALICYLIC ACID

THE dissociation constants of 3,5-dinitrosalicylic acid were determined potentiometrically at constant ionic strength. The  $pK_1$  and  $pK_2$  values obtained at  $35 \pm 0.2^\circ$  C. are  $2.96 \pm 0.04$  and  $7.61 \pm 0.08$  respectively.

The dissociation constants of 3,5-dinitrosalicylic acid (3,5-DNS) have not been reported in the literature. In view of this and for the study of metal complexes with 3,5-DNS, it was of interest to determine the dissociation constants of this acid.

3,5-Dinitrosalicylic acid (Reidel-De Heen AG Seclze-Hannover, Made in Germany) and AnalaR (B.D.H.) reagents  $KNO_3$  and  $NaOH$  were used and their solutions were prepared in doubly distilled air-free conductivity water. Freshly prepared solutions of reagents were used to avoid the effects of age and hydrolysis.

A Cambridge bench pattern (null-deflection type) pH meter was used for pH measurements, which gives values accurate up to 0.02 pH unit. A glass electrode of 0-14 pH range, calibrated frequently by using buffer solutions of different pH values, was used in conjunction with a saturated calomel electrode connected to the cell by a low resistance salt bridge. All measurements were performed at a constant ionic strength of 0.1M, which was maintained by adding a requisite quantity of  $KNO_3$ . The temperature was maintained constant by placing the titration cell in an electrically regulated thermostat. The values of  $pK_1$  and  $pK_2$  were determined by using the Albert and Serjeant's<sup>1</sup> method. The  $pK_1$  and  $pK_2$  values obtained at  $35 \pm 0.2^\circ$  C. are  $2.96 \pm 0.04$  and  $7.61 \pm 0.08$  respectively.

Department of Chemistry, S. S. DUBE.  
Government College, S. S. DHINDSA.  
Kota (Rajasthan), August 5, 1968.

1. *Ionisation Constants of Acids and Bases*, Adrein Albert and E. P. Serjeant, Methuen and Co. Ltd., London; John Wiley and Sons, Inc., New York, 1962.

### CADMIUM (II) COMPLEXES WITH 2-METHYL QUINOLINE

As a part of our investigations on nitrogen-bonded metal complexes, we had earlier reported<sup>1</sup> some cadmium (II) complexes with substituted pyridines. This communication describes some more complexes using a substituted (2-methyl) quinoline as a ligand (L).

All the compounds were prepared in ethanolic medium by reacting cadmium halide  $CdX_2$ , where  $X = Cl^-, Br^-, I^-$  and  $CNS^-$  and the ligand in 1:2 ratio. There was an almost immediate formation of the compounds which were filtered, washed with ethanol followed by petroleum ether and dried *in vacuo*. The purity of the isolated compounds was established by estimating the metal as  $Cd NH_4 PO_4 \cdot H_2O$  and the halogen as silver halide. The conductance measurements were carried out in acetone medium at  $25^\circ$  C. using a Toshniwal conductance bridge. The analytical and conductance data are recorded in Table I.



TABLE I

Analyses, melting point and conductance of Cd (II) complexes with 2-methyl quinoline (L)

Name of the complex	Formula	M.P. °C.	% Cadmium		% Halogen		$\Delta_m$ (mhos) in acetone
			Required	Found	Required	Found	
Dichloro mono 2-methyl quinoline cadmium (II)	[CdLCl <sub>2</sub> ]	>260	34.4	33.9	21.7	21.7	6
Dibromo mono 2 methyl quinoline cadmium (II)	[CdLBr <sub>2</sub> ]	>260	27.0	27.0	35.5	35.7	15
Diiodo mono 2-methyl quinoline cadmium (II)	[CdLI <sub>2</sub> ]	240.4	22.0	22.0	49.8	49.6	8
Dithiocyanato bis-2-methyl quinoline cadmium (II)	[CdL <sub>2</sub> (SCN) <sub>2</sub> ]	215	21.8	21.7	22.5	21.6	24

The compound dithiocyanato bis-(2-methyl quinoline) cadmium(II) is diamagnetic at room temperature and is evidently a tetrahedral compound. It is fairly soluble in acetone and the low value for  $\Delta_m$  indicates that it is essentially a non-electrolyte since the value for 1:1 electrolytes is round about 150 mhos. The thiocyanate groups are terminal but not bridging as indicated by the infra-red spectrum recorded on Nujol mull. Two sharp bands are observed at 815 cm.<sup>-1</sup> and 2090 cm.<sup>-1</sup> which can be assigned to C-S and C-N stretching frequencies. While studying the I.R. spectra of thiocyanato complexes of manganese (II), we reported<sup>2</sup> earlier a similar behaviour based on the arguments advanced by Chatt and Duncanson.<sup>3</sup>

The compounds having the formula CdLX<sub>2</sub> are only apparently three-co-ordinated. They have high melting points and are only sparingly soluble in common organic solvents. They are presumably dimers involving halogen bridges which increases effectively the co-ordination number to 4. We had however noticed<sup>1</sup> earlier a similar behaviour in CdLX<sub>2</sub> complexes where L is 4-methyl pyridine or 2-amino 4-methyl pyridine.

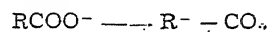
Thanks are due to the Ministry of Education, Government of India, for granting a Research Training Scholarship to one of us (B. P.).

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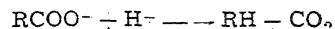
1. Paul, B. and Ramana Rao, D. V., *J. Ind. Chem. Soc.*, 1967, **44**, 532.
2. Dash, K. C. and Ramana Rao, D. V., *Curr. Sci.*, 1966, **35**, 462.
3. Chatt, J. and Duncanson, L. A., *Nature*, 1956, **178**, 997.

### THERMAL DECARBOXYLATION OF SUBSTITUTED SALICYLIC ACIDS

THERMAL decarboxylations of acids can occur by either of the two conceivable electrophilic substitution mechanisms, namely, S<sub>E</sub>1 or S<sub>E</sub>2. The former can be expressed by



and the latter by



The S<sub>E</sub>2 mechanism is favoured by a high electron density on the carbon atom next to the carboxyl group. This mechanism which is bimolecular involves an acid molecule and a solvated proton and therefore, acids which decarboxylate in this manner will be stable in alkaline but unstable in acid medium. In this paper, we present the kinetics of decarboxylation of 3-nitro- and 3,5-dinitrosalicylic acids, which was undertaken to see the effect of substitution on the rate.

All the chemicals used were of analar grade and the solvents of extra pure quality. The experimental procedure and calculation of rate constants were the same as described earlier.<sup>1</sup> In all experiments the final volume of carbon dioxide was about 99% of the theoretical yield. The reaction was studied at 190°, 200°, 210° and 220° C.

Neither of the nitrosubstituted salicylic acids underwent decarboxylation in the solvents glycerol or glycol in the temperature range studied. However, the decarboxylation is smooth in the acidic solvent resorcinol, where pseudo first order kinetics were observed. The rate constants and the other thermodynamic parameters are given as

$$\begin{aligned} & \text{3-nitro salicylic acid } k \text{ (sec}^{-1}\text{)} \\ & = 3.356 \times 10^{-4}, \Delta E \text{ (k cal./mole)} = 27.47, \end{aligned}$$

$$\begin{aligned}\Delta H^*_{473^\circ K} \text{ (k cal.)} &= 26.53, \quad \Delta F^* \text{ (k cal.)} \\ &= 34.71, \quad \Delta S^* \text{ (e.u.)} = -17.29, \\ 3\text{-5-dinitro salicylic acid } k \text{ (sec.}^{-1}\text{)} &= 2.819 \times 10^{-4}, \\ \Delta E \text{ (k cal./mole)} &= 22.89, \quad \Delta H^*_{473^\circ K} \\ \text{(k cal.)} &= 21.95, \\ \Delta F^* \text{ (k cal.)} &= 34.88, \quad \Delta S^* \text{ (e.u.)} = \\ &= -27.34.\end{aligned}$$

Brown, Hammick and Scholefield<sup>2</sup> found that salicylic acid decarboxylates by an  $S_E2$  mechanism in the acidic solvent resorcinol. From our recent studies it has been found that meta nitro benzoic acid does not decarboxylate in resorcinol but in glycerol, while 3-nitro salicylic acid undergoes decarboxylation only in resorcinol. This shows that both salicylic acid and 3-nitro salicylic acid decarboxylate by the same mechanism, namely,  $S_E2$  and that the presence of  $\text{NO}_2$  group, which incidentally will deactivate the ring, affects the  $\alpha$  carbon atom, that is in the meta position to nitro group, least. The predominating effect is that of hydroxyl group in the  $o$ -position, which increases the electron density of  $\alpha$  carbon atom and hence it should decarboxylate by an  $S_E2$  mechanism. The introduction of another nitro group, in the 3-5-dinitro salicylic acid, will be to further deactivate the ring and hence the rate should be less than that of 3-nitro compound. The above values show the same trend but the effect is not very pronounced.

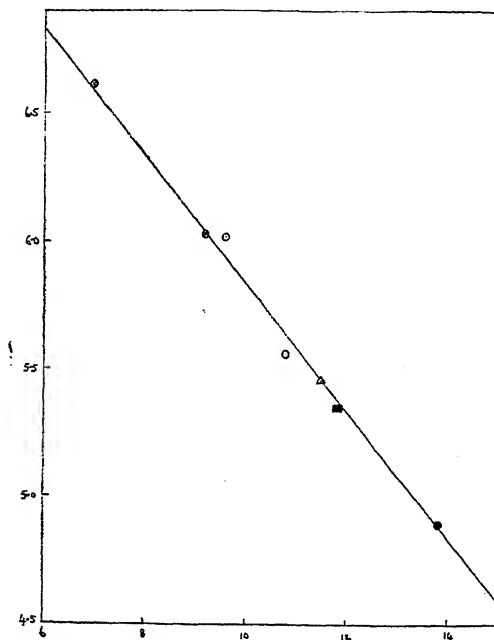
Hinshelwood and Fairclough<sup>3</sup> found that for a series of related reactions, a plot of  $1/E^{1/2}$  against  $\log \text{PZ}$  gives a linear relationship. In Table I, the acids which decarboxylate by  $S_E2$  mechanism in the solvent resorcinol have been collected along with their  $E$  values and  $\log \text{PZ}$  values.

TABLE I

Compound	E	$10^3/E^{1/2}$	$\log \text{PZ}$	Reference
Benzoic acid ..	41,900	4.886	13.81	4
Salicylic acid ..	33,600	5.456	11.50	2
3-Nitro salicylic acid	27,470	6.034	9.21	Present work
3, 5-Dinitro salicylic acid	22,890	6.610	7.02	do.
<i>p</i> -Chlorobenzoic acid	34,900	5.353	11.81	5
<i>o</i> -Chlorobenzoic acid	32,300	5.563	10.83	6
2, 4-Dichlorobenzoic acid	27,600	6.020	9.60	6

The plot of  $10^3/E^{1/2}$  against  $\log \text{PZ}$  is shown in Fig. 1, which gives a fairly linear relation-

ship the slope =  $d \log \text{PZ}/d (1/E^{1/2})$  comes as  $-4.0 \times 10^3$  which agrees fairly well, with the value of  $-5 \times 10^3$  obtained from the graph given by Hinshelwood and Fairclough<sup>3</sup> for decarboxylation of substituted malonic acids.

FIG. 1. A plot of  $\log_{10} \text{PZ}$  against  $10^3/E^{1/2}$ .Abscissa— $\log_{10} \text{PZ}$ .Ordinate— $10^3/E^{1/2}$ .

The authors wish to thank Prof. N. V. Subba Rao for his keen interest.

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Hyderabad-7, June 29, 1968. S. S. MUHAMMAD.

1. Muhammad, S. S., Mrs. Lalitha, J. and Sundaram E. V., *Acta Chem. Hungarica*, 1960, **22**, 455.
2. Brown, B. R., Hammick, D. H. and Scholefield, A. J. B., *J. Chem. Soc.*, 1950, p. 778.
3. Hinshelwood, C. N. and Fairclough, R. A., *Ibid.*, 1937, **538**, 1573.
4. Muhammad, S. S. and Aziz Siddiqui, *J. Ind. Chem. Soc.*, 1954 **31**, 726.
5. —, *Bull. Chem. Soc., Japan*, 1960, **33**, 1154.
6. — and Aziz Siddiqui, *J. Ind. Chem. Soc.*, 1956, **33**, 570.

# OCCURRENCE OF OLEANOLIC ACID IN THE PODS OF *WRIGHTIA TINCTORIA* BR.

THE chemical examination of the leaves and pods of *Wrightia tinctoria* Br. (Apocynaceae) has been recently reported by us.<sup>1</sup> The results of further examination of the pods are reported here.

The powdered pods (freed from seeds) were extracted with hexane followed by hot chloroform. The hexane extract residue was saponified and the non-saponifiable matter was separated into hot methanol soluble and sparingly soluble fractions. The methanol soluble portion gave a substance, colourless feathery needles from methanol, m.p. 182-84°, ( $\alpha$ )<sub>D</sub> + 83.6° (chf.). It formed a monoacetate, m.p., 222-24°, ( $\alpha$ )<sub>D</sub> + 79° (chf.). They were identified as  $\alpha$ -amyrin\* and its acetate respectively by comparison with the corresponding authentic samples.<sup>2</sup>

The methanol sparingly soluble part was chromatographed over alumina when a sterol was obtained, besides an additional quantity of  $\alpha$ -amyrin. The sterol, m.p. 134-36°, ( $\alpha$ )<sub>D</sub> 40.5° (chf.), was identified as  $\beta$ -sitosterol by direct comparison with an authentic sample<sup>2</sup> and preparing its acetate, m.p. and m.m.p. 124-26°.

The isolation of ursolic acid from the chloroform extract of the pods has already been described.<sup>1</sup> The crystalline solid obtained from the mother liquors of ursolic acid was acetylated using pyridine and acetic anhydride. Crystallization of the acetylated product from ethanol gave a substance, shining prisms, m.p. 250-53°. This was deacetylated using N/2 alcoholic KOH. The product crystallized from methanol as colourless needles, m.p. 300-05°, ( $\alpha$ )<sub>D</sub> + 78° (chf.). The deacetylated product formed a methyl ester with diazomethane, m.p. 200-02°, ( $\alpha$ )<sub>D</sub> + 74° (chf.) showing that it is an acid. The original acetate also formed a methyl ester, colourless shining plates from ethanol, m.p. 220-22°, ( $\alpha$ )<sub>D</sub> + 70° (chf.). These properties suggested that the acid might be oleanolic acid. This was confirmed by direct comparison (m.p., m.m.p. and colour reactions) of the acid, its acetate and their methyl esters with authentic samples<sup>3</sup> of oleanolic acid and its corresponding derivatives. The mother liquors of oleanolic acid contained mainly ursolic acid acetate.

The microcrystalline solid, m.p. 262-64°, described earlier<sup>1</sup> has since been found to be a

mixture of mainly ursolic acid and oleanolic acid. Pure entities of the two acids were obtained through the acetylation procedure described above.

The co-occurrence of  $\alpha$ -amyrin, ursolic acid and oleanolic acid along with  $\beta$ -sitosterol in the pods of *Wrightia tinctoria* may be of some biogenetic interest.

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Waltair. July 15, 1968. V. SUBBA RAO.

\* All the substances described in this note gave satisfactory elemental analysis.

1. Rao, M. N., Rao, E. V. and Rao, V. S., *Curr. Sci.*, 1966, 35, 515.
2. Rangaswami, S. and Rao, E. V., *Proc. Ind. Acad. Sci.*, 1960, 52A, 173.
3. Rao, G. S. R. S. and Rao, L. R., *Tetrahedron*, 1962, 18, 827.

## SYNTHESIS OF BENZOTHAZOLYL GUANIDINES

IN view of the significant algæcidal,<sup>1</sup> antibacterial<sup>2</sup> and antitubercular<sup>3</sup> activities of benzothiazolyl guanidines, it was considered worthwhile to synthesize some new diaryl guanidines in which one aryl group is *p*-chlorophenyl and another a substituted benzothiazolyl group.

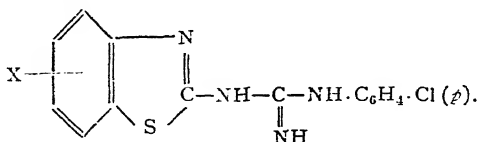
In the present communication 2-amino-(substituted) benzothiazoles<sup>4</sup> were condensed with *p*-chlorophenyl isothiocyanate<sup>5</sup> and the resulting benzothiazolyl thiocarbamides<sup>6</sup> were desulphurized with yellow lead oxide in ethanolic ammonia or ethanolic methylamine solution.

### EXPERIMENTAL

*N-p-Chlorophenyl-N'-2-(4-chloro)benzothiazolyl guanidine*.—*N-p*-chlorophenyl-*N'*-2-(4-chloro) benzothiazolyl thiocarbamide (3.3 g.), yellow lead oxide (5 g.) and strong ethanolic ammonia (25 ml.) were heated in sealed glass-tube on a water-bath for 3-4 hours. Lead sulphide was filtered while hot and it was again extracted with hot ethanol. The filtrate was concentrated to get *N-p*-chlorophenyl-*N'*-2-(4-chloro) benzothiazolyl guanidine. It was recrystallized from ethanol. The yields, melting points and analytical results of the guanidines prepared in this way are given in Table I.

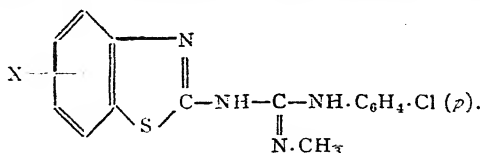
*N-p-Chlorophenyl-N'-2-benzothiazolyl N'-methyl guanidine*.—A mixture of *N-p*-chlorophenyl-*N'*-2-benzothiazolyl thiocarbamide (3.1 g.), yellow lead oxide (5 g.), 33% aqueous methylamine solution (4 ml.) and ethanol

TABLE I

*N*-*p*-Chlorophenyl-*N'*-2-(substituted)benzothiazolyl guanidines

Sl. No.	Substituent X	Yield %	M.P. °C.	Molecular formula	Carbon %		Hydrogen %	
					Found	Calcd.	Found	Calcd.
1	4-Chloro-	70	185	C <sub>14</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>4</sub> S	49.97	49.85	3.06	2.97
2	5-Chloro	73	227	C <sub>14</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>4</sub> S	50.03	49.85	2.98	2.97
3	6-Chloro-	85	197	C <sub>14</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>4</sub> S	50.10	49.85	3.11	2.97
4	4-Methoxy-	50	140	C <sub>15</sub> H <sub>13</sub> ClN <sub>4</sub> OS	54.27	54.16	3.93	3.91
5	6-Methoxy-	65	206	C <sub>15</sub> H <sub>13</sub> ClN <sub>4</sub> OS	54.07	54.16	3.85	3.91
6	6-Ethoxy-	70	187	C <sub>16</sub> H <sub>15</sub> ClN <sub>4</sub> OS	55.66	55.42	4.38	4.33
7	6-Bromo-	75	199	C <sub>14</sub> H <sub>10</sub> BrClN <sub>4</sub> S	43.86	44.03	2.75	2.62

TABLE II

*N*-*p*-Chlorophenyl-*N'*-2-(substituted)benzothiazolyl-*N''*-methyl-guanidines

Sl. No.	Substituent X	Yield %	M.P. °C.	Molecular formula	Carbon %		Hydrogen %	
					Found	Calcd.	Found	Calcd.
1	4-Methyl-	65	210	C <sub>16</sub> H <sub>15</sub> ClN <sub>4</sub> S	58.23	58.11	4.61	4.54
2	5-Methyl-	70	201	C <sub>16</sub> H <sub>15</sub> ClN <sub>4</sub> S	58.30	58.11	4.45	4.54
3	6-Methyl-	85	211	C <sub>16</sub> H <sub>15</sub> ClN <sub>4</sub> S	58.35	58.11	4.65	4.54
4	4-Chloro-	76	146	C <sub>15</sub> H <sub>13</sub> Cl <sub>2</sub> N <sub>4</sub> S	51.50	51.29	3.59	3.42
5	5-Chloro-	80	160	C <sub>15</sub> H <sub>13</sub> Cl <sub>2</sub> N <sub>4</sub> S	51.11	51.29	3.60	3.42
6	6-Chloro-	84	167	C <sub>15</sub> H <sub>13</sub> Cl <sub>2</sub> N <sub>4</sub> S	51.45	51.29	3.47	3.42
7	4-Methoxy-	60	221	C <sub>16</sub> H <sub>15</sub> ClN <sub>4</sub> SO	55.35	55.42	4.50	4.33
8	6-Methoxy-	70	163	C <sub>16</sub> H <sub>15</sub> ClN <sub>4</sub> SO	55.62	55.42	4.39	4.33
9	6-Ethoxy-	75	145	C <sub>17</sub> H <sub>17</sub> ClN <sub>4</sub> SO	56.39	56.58	4.89	4.71
10	6-Bromo-	80	149	C <sub>15</sub> H <sub>13</sub> BrClN <sub>4</sub> S	45.63	45.52	3.20	3.03

(50 ml.) in sealed glass-tube was heated on a water-bath for 3 hours. The rest of the procedure for its isolation was as described above, m.p. 208° C., yield 80% (Found: C, 56.92; H, 4.23. C<sub>15</sub>H<sub>13</sub>ClN<sub>4</sub>S requires C, 56.87; H, 4.11%).

Similarly, various *N*-*p*-chlorophenyl-*N'*-2-(substituted) benzothiazolyl-*N''*-methyl guanidines have been prepared. Their yields, melting points and analytical data are recorded in Table II.

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1. Singh, G. C., *J. Ind. Chem. Soc.*, 1948, **45**, 27.
2. Bhargava, P. N. and Ram, P., *Ind. J. Chem.*, 1967, **4**, 95.
3. — and Chaurasia, M. R., *Curr. Sci.*, 1968, **37**, 347.
4. — and Baliga, B. T., *J. Ind. Chem. Soc.*, 1958, **35**, 807.
5. Blatt, A. H., *Organic Syntheses Coll.*, John Wiley & Sons, Inc., 1948, **1**, 448.
6. Bhargava, P. N. and Ram, P., *Ind. J. Appl. Chem.*, 1961, **24**, 181.

PRODUCTION AND STABILITY OF  
HETEROKARYONS OF THE  
PHYTOPATHOGENIC  
FUNGUS *FUSARIUM VASINFECTUM*\*

Buxton has observed that the frequent changes seen in morphology and in pathogenicity of *F. oxysporum* cannot be due to mutation alone.<sup>1</sup> This may be due to variety of segregants produced by mitotic crossing over by parasexual cycle observed in imperfect fungi.<sup>2-4</sup> An attempt has been made to produce established heterokaryons of mutants of *Fusarium vasinfectum* and to study the pattern of segregation.

Four mutant strains with the following requirements uracil, p-amino-benzoic acid (two non-allelic), nicotinic acid (partial-requiring) produced in this laboratory were used. For heterokaryotic studies, the minimal medium (MM) and complete medium (CM) used in these investigations had the composition as described by Pontecorvo. However, mutant strains were maintained on Czapek's medium supplemented with the required nutrient.

Nearly equal number of conidia of two mutants were transferred aseptically into a test-tube containing 1% complete medium and incubated for 72 hours. The slimy mass was cut into bits under aseptic conditions and half the number of bits were transferred to petri plates containing MM and the rest to petri plates containing CM. They were incubated at room temperature for 48 to 72 hours and the growth of the colonies was compared. If the growth of the colony in the MM plate is almost equal

to that observed in CM plate, then heterokaryosis is demonstrated. This is further confirmed by transferring the hyphal tips from the MM plate to another MM plate and incubating at room temperature for 48 hours, when it is observed that the growth in MM is almost equal to that in CM plate.

Isolation of the component strains from heterokaryon is done as follows. A uniform conidial suspension of 72-hours-old heterokaryon was prepared in saline and plated on plates containing CM. At the end of the incubation time, the conidia were replicated on to petri dishes containing MM and MM containing the particular nutrient. After incubation for 48 hours, the colonies formed were counted. The ratio between each of the mutants as also the percentage segregation were calculated. It was observed that the percentage segregation of 72-hours-old heterokaryon was below 20. An attempt to increase the percentage segregation was made by incubating at 37° C., the heterokaryotic conidia immediately after they were transferred to CM plates for varying lengths of time (for 1 to 3 hours). Even this shock treatment did not increase the percentage segregation.

The results are presented in Table I. It is interesting to note that the percentage segregation of heterokaryon increases with the increase in the age of the heterokaryon, reaching the maximum in heterokaryons of 30-days-old. Though incubation of the plates at 37° C. for different lengths of time did not hasten the segregation, yet it can very well be seen

TABLE I  
Segregation analysis of heterokaryons of *F. vasinfectum*

Age of the heterokaryons in days	Shock period in hours	No. of colonies tested	Heterokaryon No. 1		% of segregation	Heterokaryon No. 2		% of segregation	Heterokaryon No. 3		% of segregation
			Uracil requirer	Nic. requirer		Paba <sub>1</sub> requirer	Nic. requirer		Paba <sub>2</sub> requirer	Nic. requirer	
3	1	104	10	12	21.2	15	19	32.7	9	11	19.2
	2	104	13	15	26.9	18	22	38.3	15	18	31.7
	3	104	16	18	32.7	13	15	26.9	13	17	28.9
7	1	104	26	30	53.9	19	23	40.4	22	28	48.1
	2	104	27	32	56.7	25	31	53.9	30	36	63.5
	3	104	32	34	54.0	17	23	38.45	16	21	35.6
14	1	104	40	42	76.9	32	36	65.2	35	41	73.1
	2	104	41	46	82.0	40	46	82.7	40	50	86.54
	3	104	36	40	73.1	29	34	60.6	32	41	70.2
30	1	104	32	42	71.2	38	42	76.9	35	44	75.96
	2	104	32	45	74.0	42	48	86.5	40	48	84.63
	3	104	24	32	53.8	36	40	73.1	34	43	74.00

that incubation for 2 hours at 37° C. increases the segregations rate and incubation for 3 hours has no definite advantage. There is not a marked difference in the percentage segregation of 14-days-old and 30-days-old heterokaryons. It is interesting to mention here that all the three heterokaryons tested are balanced ones in the sense that they contain nearly equal number of component strains. The high percentage of segregation in older heterokaryons suggests that the heterokaryotic state is very unstable.

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Madras, July 29, 1968.

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1. Buxton, E. W., *Trans. Brit. Mycol. Soc.*, 1958, **41**, 396.
2. —, *J. Gen. Microbiol.*, 1956, **15**, 133.
3. Hastie, A. C., *Genet. Res.*, 1964 **5**, 305.
4. Buxton, E. W., *Trans. Brit. Mycol. Soc.*, 1962, **45**, 274.

## AN ESTIMATE OF ALGIN-BEARING SEaweEDS IN THE GULF OF KUTCH

ATTEMPTS to estimate the quantity of algin-bearing seaweeds in India<sup>1,2</sup> have so far been restricted to two small areas. Extensive growth of *Sargassum* spp., which form the main source of algin in India, were observed in the Gulf of Kutch area and we decided to start our survey there. Six stations, Dera, Goos, Narara, Sika, Karumbhar and Baida were selected for carrying out the survey in the first instance. Earlier work in our laboratories<sup>3</sup> showed that the yield and quality of algin were superior in weeds collected during the winter months and so the work was carried out during the period of November 1967 to January 1968.

The estimate was based on random samples over fairly large sections of coastal waters and the method of sampling as well as calculation of the estimated quantity of seaweed were similar to those of Walker.<sup>4</sup>

The sampling stations, total area surveyed in each sampling station and the estimated quantities of total seaweeds, *Sargassum* spp., and other algin-bearing weeds are given in Table I.

Altogether 10.65 km.<sup>2</sup> of coastal waters were surveyed and a total of 18,765.5 metric tons of seaweeds were estimated in these areas. Of

TABLE I  
Estimate of algin-bearing seaweeds on the  
Gujarat coast

Section	Area (sq. km.)	Fresh weight in metric tons		
		Total seaweeds	<i>Sargassum</i>	Other algin weeds
Dera ..	1.55	2391	1400	520
Goos ..	3.00	7300	5550	1720
Narara ..	4.00	5920	2720	480
Sika ..	0.50	1209.5	1120.5	33
Karumbhar	0.10	175	140	..
Baida ..	1.50	1710	1080	..

this quantity, *Sargassum* spp. account for 12,010.5 tons. There were only two species of *Sargassum* involved, *S. tenerimum* and *S. cinereum* and the first named species was the most abundant. As it has been found by one of us (V. D. C.) that the life span of *Sargassum* on the Gujarat coast was generally two years and was probably never more than three years, it would be desirable to harvest only one-third of the available weeds in any one year so that full regeneration of the standing crop was facilitated. Even so, about 4,000 metric tons of fresh *Sargassum* can be harvested each year in the gulf of Kutch alone, a quantity which is sufficient to produce about 80 tons of alginic acid.

We wish to thank Dr. D. S. Datar for his kind interest and the Department of Fisheries of Government of Gujarat, Ahmedabad, for their help in carrying out this survey.

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1. Sreenivasa Rao, P., Iyengar, E. R. R. and Francesca Thivy, *Curr. Sci.*, 1964 **33**, 464.
2. Prasanna Varma, R. and Krishna Rao, K., *Indian J. Fish.*, 1962, **9 A**, 205.
3. Chauhan, V. D., *Ph.D. Thesis*, Bombay University, 1967.
4. Walker, F. T., *J. Ecol.*, 1947, **35**, 166.

## CO-EXISTING PYROXENES FROM PYROXENE GRANULITES

WHILE surveying an area of about 60 square miles around Chimakurti (Guntur District, Andhra Pradesh), Lat. 15° 35'–15° 42' N and Long. 79° 47'–79° 53' E, pyroxene granulites (basic division of the charnockite series) represented by gabbro, norite, hornblende norite, etc., were noticed along with paragneisses and quartzites. In the present account an attempt

is made to bring out the significance of co-existing pyroxenes (ortho- and clino-) from the pyroxene granulites.

Hess<sup>1</sup> has shown that the co-existing pyroxenes from the igneous rocks, when plotted on En-Fs-Wo diagram, the projections of the joins of the pairs of pyroxenes intersect the En-Wo side of the triangle at positions approximating to  $Wo_{7.5}$ . Muir and Tilley<sup>2</sup> have indicated a similar relationship for the co-existing pyroxenes in the metamorphic assemblages. Wilson<sup>3</sup> employed the tie line intersection of pyroxenes on En-Wo side of the En-Wo-Fs triangle, in distinguishing the mobilised granulites which fall close to  $Wo_{7.5}$  from the pyroxene granulites of the amphibolite facies, which fall close to  $Wo_{8.5}$ . Wilson's conclusions were criticised by O'hara<sup>4</sup> and by Brown,<sup>5</sup> who have pointed out the discrepancies between compositions obtained by optics and by chemical analyses. From the discussion it is clear that tie line intersections at about  $Wo_{7.5}$  may not help in distinguishing the igneous pyroxenes from the metamorphic pyroxenes (irrespective of whether the compositions are obtained from chemical analyses or optical data).

The three pairs of pyroxenes (ortho- and clino-), whose analyses are not given here, when plotted on the En-Fs-Wo diagram (Fig. 1)

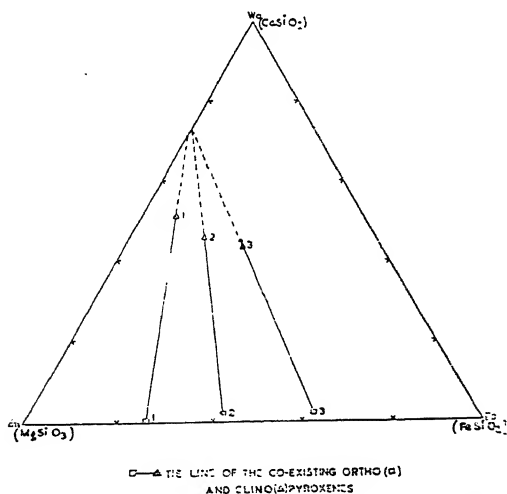


FIG. 1. Wo, Fo, En diagram (after Hess, 1940).

have shown their tie line intersections at  $Wo_{7.3}$  for two pairs and at  $Wo_{7.1-5}$  for another pair. A similar positioning of the tie lines was obtained for the pyroxene pairs of the Madras charnockite series (Howie<sup>6</sup>). Howie<sup>6</sup> states

that such positioning of the tie lines is true for all pyroxenes which have crystallised under equilibrium conditions.

The recent investigations of Mueller,<sup>7</sup> Kretz<sup>8,9</sup> and Bartholomé<sup>10,11</sup> show that the distribution coefficient  $K_D$  (Mg-Fe) of pyroxene is a useful parameter in distinguishing the igneous pyroxenes from metamorphic pyroxenes. The three pairs have given values 0.502, 0.613 and 0.527 for gabbro, hornblende-norite and biotite-norite respectively. The average of these three works out to be 0.544; almost the same value (0.54) was obtained for the Madras charnockites also.

It has been noted by Kretz<sup>9</sup> that there is a distinct tendency for the distribution coefficient to lie near the value of 0.54 or 0.73, representing mineral pairs from supposed 'metamorphic' rocks and 'igneous' rocks respectively. Kretz<sup>9</sup> from thermodynamic considerations arrived at the conclusion that the distribution coefficient  $K_D$  is a function of temperature and pressure and is independent of chemical variations. Binns<sup>12</sup> from the study of the Broken Hill pyroxenes shows that the distribution coefficient is not invariant under constant temperature and pressure conditions, but depends on composition. In the present state of our knowledge, it is not possible to know whether  $K_D$  is controlled by P-T conditions or by composition, until more analytical data are available for pyroxene pairs of known paragenesis.

Rocks which are considered as metamorphic rocks, but having high  $K_D$  values are explained by Kretz<sup>13</sup> that they were once igneous rocks, which were subsequently recrystallised at 'metamorphic' temperatures but whose distribution coefficient remained unchanged during this operation. Such rocks were crystallised originally near liquidus temperatures. But rocks having  $K_D$  values around 0.54 have not crystallised near liquidus temperatures, but are formed at much lower temperatures. A temperature of about 670° C. was given by Howie (Kretz<sup>14</sup>) for Madras charnockites which have an average  $K_D$  value of 0.54. Same value is obtained for the charnockites of the present area and hence temperature given by Howie holds good for the rocks of the present investigation.

The investigation of the co-existing pyroxenes indicates the equilibrium conditions for the pyroxene granulites. The distribution coefficient of Mg and Fe further shows that the pyroxene granulites are formed at 670° C.

The writer wishes to thank Professor M. G. Chakrapani Naidu for his guidance and Dr. M. S. Murty for critically reading the manuscript and suggesting improvements.

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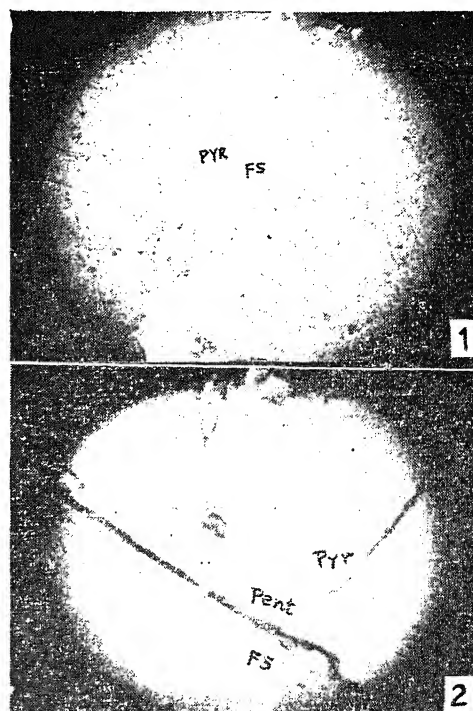
1. Hess, H. H., *Am. Mineralogist*, 1941, 26, 515 and 573
2. Muir, I. D. and Tilley, C. E., *Geol. Mag.*, 1958, 95, 403.
3. Wilson, A. F., *Trans. Roy. Soc. S. Australia*, 1960, 83, 37.
4. O'hara, M. J., *Geol. Mag.*, 1980, 97, 498.
5. Brown, G. M., *Ibid.*, 1961, 98, 333.
6. Howie, R. A., *Controls of Metamorphism*, Oliver and Boyd Co., 1965, p. 319.
7. Mueller, R. F., *Am. J. Sci.*, 1960, 258, 449.
8. —, *Geochim. et Cosmochim. Acta*, 1961, 25, 267.
9. Kretz, R., *Jour. Geol.*, 1961, 69, 361.
10. —, *Ibid.*, 1963, 71, 773.
11. Bartolomé, P., *Geol. Mag.*, 1961, 98, 346.
12. —, *Geol. Soc. Amer.*, *Buddington Vol.*, 1962, p. 1.
13. Binns, R. A., *Min. Mag.*, 1962, 33 (259), 320.

#### OCCURRENCE OF PYRRHOTITE AND CHALCOPYRITE IN KASIPATNAM, ANDHRA PRADESH

In the course of recent investigations in Kasipatnam area (18° 17" N: 83° 09" E.), Andhra Pradesh, an occurrence of pyrrhotite in association with apatite-magnetite veins was noticed. Thin section study revealed that the material in which pyrrhotite is found is essentially ferrosalite. Pyrrhotite occupies the weaker zones of ferrosalite in the form of small veinlets and segregations (Fig. 1). Along the contacts of pyrrhotite and ferrosalite, and also along cracks and cleavage planes of pyrrhotite, small veinlets and disseminated grains of chalcopyrite occur.

Pyrrhotite has been identified from its bronze-yellow colour, tendency to get tarnished in air, strong magnetic property and easy solubility in hydrochloric acid with the liberation of hydrogen sulphide. The above mineral assemblage was studied under an ore microscope and megascopic identification of pyrrhotite was confirmed from the brownish-cream colour with high reflectivity, faint pleochroism in oil, and etch reaction with KOH which tarnishes the mineral to iridescent brown. Chalcopyrite was identified from its brass-yellow colour with noticeable faint pleochroism. In association with pyrrhotite and at its edge, a small blade-like form with

cubic cleavage is noticed. From its high reflectivity, white colour, and etch reactions (negative to KOH, temporary brown stain with aqua regia, and lack of effervescence with  $\text{HNO}_3$ , which gives a temporary brown stain), this has been identified as pentlandite (Fig. 2), an iron-nickel sulphide, which usually occurs in association with pyrrhotite.



FIGS. 1-2. Fig. 1. Pyrrhotite (Pyr) vein in ferrosalite (Fs). Polarized illumination,  $\times 16$ . Fig. 2. Pentlandite (Pent) and pyrrhotite (Pyr) in ferrosalite (Fs). Polarized illumination,  $\times 30$ .

The apatite-magnetite veins are found along the NW-SE joints of biotite-gneisses which strike NE-SW. The veins often exhibit zoning-features resembling igneous zoning in pegmatites. Ferrosalite forms the outer zone followed by inner apatite zone with or without intermediate vermiculite zone. It is believed that the ore-bearing solutions started migration after the stage of apatite formation, and occupied the fractures and other such spaces available in already congealed ferrosalite zone. The ore-minerals exhibit replacement relationship with ferrosalite. The first ore-mineral to be formed is believed to be pyrrhotite, followed by chalcopyrite which replaces the former preferably along the cleavage planes. Pentlandite is believed to



have been formed simultaneously with pyrrhotite. The occurrence of ore-minerals in other rock types and their persistence at depth needs further investigation.

The authors are grateful to Prof. A. Sriramadas for valuable suggestions and facilities.

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**DICOTYLEDONOUS LEAF-IMPRES-  
SIONS FROM THE RAJAHMUNDRY  
SANDSTONES NEAR PANGADI,  
WEST GODAVARI  
DISTRICT, A.P.\***

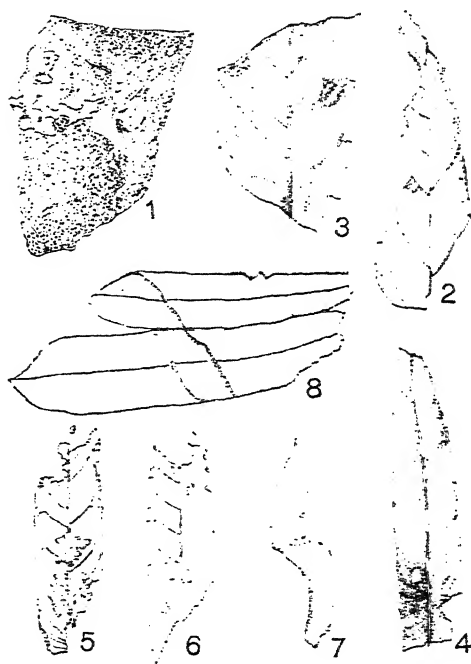
The plant impressions collected by the authors during May, 1967, from the Rajahmundry sandstones exposed in a sandstone quarry at Minanagaram (17° 00' 30": 81° 39' 30"), about 1.5 km., south of Pangadi, West Godavari District, A.P., are being described. In this quarry the Rajahmundry sandstones are coarse-grained, at places gritty and conglomeratic, ferruginous and current-bedded, and variegated. There are occasional interstratified thin bands of clay, shale and conglomerate. The fossils described come from these interstratified lenticular fine-grained greyish-white and pink shales, which though laminated do not easily break along the laminations.

The Rajahmundry sandstones are considered to be equivalents of Cuddalore sandstones.<sup>1-3</sup> However, in the absence of common fossils in the Cuddalores and the Rajahmundrys it is not possible to precisely correlate one with the other. The Cuddalores are considered to be of Upper Miocene to Lower Pliocene age by Ramanujam<sup>1</sup> and 'not older than Upper Tertiary' by Pascoe.<sup>3</sup> It is rather difficult to fix the age of these sandstones on the basis of the present find of leaf-impressions.

The climate of the epoch, during which these plants flourished, appears to be tropical, not much different from the one that prevails now along the east coast of South India. Of considerable interest is the absence of plants with compound foliage, conifers, other gymnosperms, ferns, grasses, sedges and fructifications among the Minanagaram fossils.

The fossils are mainly leaf-impressions and are rather not very well preserved. From their preserved shape and venation the leaves are definitely dicotyledonous, but in the absence of any dependable characters of taxonomic value it has not been possible to assign them to any specific genera. They have, therefore, been described under the form-genus *Dicotylophyllum* Saporta.<sup>5</sup> It has been possible to distinguish at least four different types of this form-genus in the present collection and the same are illustrated by camera-lucida drawings, as detailed below:

- (a) *Dicotylophyllum* sp. 1: Figs. 1-3; G.S.I. Type nos. 18342-18344.
- (b) *Dicotylophyllum* sp. 2: Figs. 4-6; G.S.I. Type nos. 18345-18347.
- (c) *Dicotylophyllum* sp. 3: Fig. 7; G.S.I. Type no. 18348.
- (d) *Dicotylophyllum* sp. 4: Fig. 8; G.S.I. Type nos. 18349-18350.



FIGS. 1-8. *Dicotylophyllum*, x 1. Figs. 1-3. *Dicotylophyllum* sp. 1. Figs. 4-6. *Dicotylophyllum* sp. 2. Fig. 7. *Dicotylophyllum* sp. 3. Fig. 8. *Dicotylophyllum* sp. 4.

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Survey of India, for their keen interest in this work.

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February 23, 1968.

\* Published with the kind permission of the Director-General, Geological Survey of India, Calcutta-13.

1. King, W., *Mem. Geol. Surv. Ind.*, 1880, 16 (3), 54.
2. Krishnan, M. S., *Geology of India and Burma*, 1960, p. 555.
3. Pascoe, E. H., *A Manual of the Geology of India and Burma*, 1963, 3, 1879.
4. Ramanujam, C. G. K., *Palaeontographica*, 1960, 106 B, 99.
5. Saporta, G., in Andrews, H. N. Jr., *Bull. Geol. Surv. Washington*, 1955, 1013.

**ON A NEW HOST RECORD FOR  
THE FISH TREMATODE  
TRANSVERSOTREMA PATIALENSIS  
(SOPARKAR, 1924) CRUZ AND  
SATHANANTHAN 1960**

CRUZ AND SATHANANTHAN<sup>1</sup> described *Transversotrema patialense* an ectoparasite underneath the scales of the freshwater fish *Macropodus cupanus* in Ceylon as the adult of the progenetic cercaria *C. patialensis* Soparkar, 1924. Although this interesting cercaria was first described<sup>2</sup> and subsequently has been reported twice,<sup>3,4</sup> from India, hitherto there is no record of the adult fluke from this country.

In our studies on the biology of larval forms and adult trematodes of Waltair we frequently encountered the cercaria emerging from *Melanoides tuberculatus* (Müll.), collected from a stream near Waltair. Life-history experiments were undertaken and simultaneously investigation of all fish hosts from the stream was carried out. The adult fluke was obtained in nature as well as in the laboratory from underneath the scales of the fish *Panchax panchax*.

The body of the mature fluke (Fig. 1) is flattened, leaf-like and transversely elongated, measuring (all measurements in millimetres) 0.312–0.375 (0.352) × 0.68–0.732 (0.72). The body has its maximum width in the region of the pharynx. It is covered with alternating rows of triangular spines. The eye-spots persisted in the adult condition as well. Oral sucker is absent. The ventral sucker is equatorial and measures 0.06–0.084 in diameter. It is pedunculate. The ventral mouth

leads into a pharynx that measures 0.036–0.052 × 0.036–0.06. The pharynx leads into a slender oesophagus which opens into a ring-like intestine. The excretory bladder is pear-shaped.

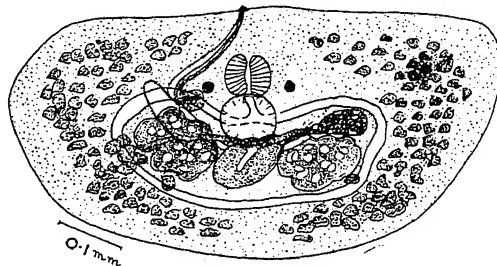


FIG. 1

The two testes as well as the ovary lie within the intestinal ring. The seminal vesicle is the most conspicuous part of the male reproductive system being packed with thousands of active spermatozoa. There is no cirrus pouch. The ovary is situated anterior to the left testis. The vitellaria are follicular and are densely distributed in all the extracæcal space. The genital pore is situated slightly to the right of the median line and is ventral. The eggs are large, oval and measure 0.112–0.130 (0.12) × 0.044–0.06 (0.056).

The genus *Transversotrema* is an interesting trematode from the point of view of life-cycle as well as its distribution and in being an ectoparasitic digenian. The first species in that genus *T. haasi* was described by Witenberg<sup>5</sup> from Red Sea. Subsequently *T. laruei* has been reported from Philippines by Velasquez<sup>6</sup> and *T. patialense* was listed when Cruz and Sathananthan<sup>1</sup> proved *C. patialensis* to be a larval form of a species in that genus. More recently Manter<sup>7</sup> reported *Transversotrema* sp. from scorpioniid fishes from Pacific. Rao and Ganapati<sup>4</sup> described immature flukes from *Panchax panchax* in India and commented on its life-history. The present communication forms the first definite report of the adult of *T. patialensis* from this country.

Our thanks are to Prof. P. N. Ganapati for his interest and encouragement. One of us (A. S. M.) thanks the C.S.I.R. for the award of a Fellowship.

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Waltair. July 29, 1968.

1. Crusz, H. R. and Sathananthan, A. H., *J. Parasit.*, 1960, **46**, 613.
2. Soparkar, M. B., *Indian J. Med. Res.*, 1924, **11**, 933.
3. Anantharaman, M., *Indian J. Helminth.*, 1948, **1**, 11.
4. Rao, Hanumantha K. and Ganapati, P. N., *Parasitology*, 1967, **57**, 661.
5. Witenberg, G., *J. Parasit.*, 1944, **30**, 179.
6. Velasquez, C. C., *Ibid.*, 1958, **44**, 449.
7. Manter, H. W., *Ibid.*, 1965, **51**, Suppl. 59.

### INHERITANCE OF NECROSIS IN WHEAT

NECROSIS is an undesirable character in wheat since it reduces the photosynthetic area of the leaf resulting in partial or complete drying. In affected leaves the drying starts at the tip and moves downwards sometimes involving leaf-sheath also. This character has its maximum expression from early tillering stage to preflowering stage.

In some Indian wheat varieties like Pb. C 306, Pb. C 303, NP 839 and NP 891, etc., crossed with Mexican dwarf varieties like Safed Lerma (S. 307) and Chhoti Lerma (S. 331), necrosis in various degrees has been a common observation. The present study aims at finding out the mode of inheritance of necrotic behaviour in some crosses of bread wheat. Observations were taken in parent varieties and in  $F_1$ ,  $F_2$  and  $F_3$  generations. A slight modification of classification suggested by Hermesen<sup>2</sup> was adopted; two of his classes—'moderate' and 'slight'—were combined.

The three categories considered were:

1. Severe—Plants drying before seed formation,
2. Intermediate—Plants showing moderate to slight necrosis with shrivelled or normal grains and
3. Normal—Plants normal.

Of the several crosses studied in the breeding programme in  $F_1$  generation, six were observed to be severely necrotic (lethals). This indicated that severe necrosis was dominant over normal. In one cross, viz., [(N 10-B 17 × Y 53) Y 50 K] × NP 891 (the former parent referred to as E 4871 from here onwards), however, out of 7  $F_1$  plants, 5 were severely necrotic and the remaining 2 were grass-clumps (Table I). It appears that in

TABLE I

Behaviour of necrosis in  $F_1$  of 7 crosses of  
*T. aestivum* L.

Sl. No.	Cross	Necrotic plants	Grass-clump	Normal plants
1	E 4871 × NP 891	..	5	2
2	E 4871 × Pb. C 306	..	15	NI
3	Safed Lerma × Pb. C 306	..	18	..
4	Pb. C 306 × E 4871	..	5	..
5	Mx5392-2* × NP 839	..	30	..
6	C 306 × Chhoti Lerma	..	1	..
7	[(E 5100* × NP 875) (C 306 × E 5673) (L. Ro)]	..	11	..

\* Kalyansona line. † Galo 50 (EC.16991).

‡ F.A.O. Acc. No. 9129.

this cross there is some heterozygosity present in the parents. In cases where all the  $F_1$  plants are showing necrosis, it is assumed that the parents involved in each cross-combination are carrying complementary factors for necrosis. Table II presents data of  $F_2$  and  $F_3$  observation. In the first three crosses the  $F_2$  segregation behaviour (13 necrotic : 3 normals) indicated the presence of one dominant factor for necrosis along with one dominant inhibitory factor. The remaining three crosses gave a segregation ratio of 55 necrotic : 9 normals suggesting that necrosis is governed by two dominant complementary factors and one dominant inhibitory factor.

TABLE II  
Segregation for necrosis in  $F_2$  and  $F_3$  generations

Sl. No.	Cross	Homozygous normal individuals/families	Heterozygous	Homozygous necrotic individuals/families	Ratio	$\chi^2$	P. value
$F_2$ —							
1	E 4870 × Agra Local	..	76	..	365	13 : 3	0.65
2	E 5000* × C 306	..	47	..	216	..	0.12
3	NP 846 × Agra Local	..	111	..	345	..	0.55
4	E 4906† × C 306	..	45	..	138	55 : 9	0.79
5	E 2842‡ × C 306	..	85	..	490	..	0.24
6	V <sub>17</sub> × Agra Local	..	49	..	330	..	0.39
$F_3$ —							
7	E 4870 × Agra Local	..	51	70	4	7 : 8 : 1	2.99
8	E 6883 × Agra Local	..	54	67	4	..	2.17
9	V <sub>17</sub> × Agra Local	..	61	49	Nil	37 : 26 : 1	2.23

\* II 50-17 × II 42-39, † My. 54 × V 48-Kt 48, P 6122,

‡ Yaqui 53 (Y × E-T).

In the cross of [(Fn × K 58 N) N 10-B 21] P 14]Kt 54 B with Agra Local (the former parent referred to as E 4870 from here onwards), the  $F_2$  segregation ratio of 13 normal : 3 necrotic was confirmed by the  $F_3$  data where the expected segregation ratio of 7 homozygous normals : 8 heterozygous : 1 homozygous necrotic was obtained. In the cross, viz., [(Ch 53 × N 10 B) Y 54] × Agra Local (the female parent referred to as E 6883 from here onwards), a similar  $F_3$  segregation was recorded. A cross between V<sub>17</sub> and Agra Local gave a  $F_3$  segregation close fitting to 37 homozygous normal : 26 heterozygous : 1 homozygous necrotic but no family was obtained which was homozygous for necrosis. Evidently, these necrotic families were lost due to non-setting of grains of the severely necrotic plants in the  $F_2$  generation.

Observations of  $F_1$  are in consonance with those made by Narula *et al.*<sup>1</sup> Hermesen<sup>2</sup> observed that hybrid necrosis in wheat was determined by the interaction of two complementary genes. But in the study reported here, in some crosses two complementary factors for necrosis plus one inhibitory factor while in others, one dominant factor for necrosis and one inhibitory factor have been found.

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Indian Agricultural D. S. RAWAT.  
Research Institute,  
New Delhi, August 1, 1968.

1. Narula, P. N., Singh, S. and Srivastava, P. S. L., *Curr. Sci.*, 1968, 35 (21), 547.
2. Hermesen, J. G., "Bastard—Necrose by tarwe (Hybrid necrosis in wheat)," *Doctoral Thesis*, Wageningen, 1962, p. 129, Varslagen van Landbouwk Onderz., 68-5.
3. —, *Euphytica*, 1963, 12, 1.

### OCCURRENCE OF FORKED ROOT-HAIRS IN THE GENUS SACCHARUM

DITTMER<sup>1</sup> reported branched root-hairs of a low frequency in a few plant species. In the course of studies on rooting pattern in sugarcane forked root-hairs were observed on roots growing in dark humid chambers. Access to the sugarcane germ plasm assembly at the Sugarcane Breeding Institute, Coimbatore, prompted a sample survey for this trait within the genus, the results of which are briefly reported in this note.

Single-eye setts were rooted in dark humid chambers maintained at  $30^\circ \pm 2^\circ \text{C}$ . Seven

days from planting, one hundred root-hairs were scored in each of the two randomly drawn epidermal peelings. Frequency of forked root-hair expressed as a percentage is presented in Table I.

TABLE I  
Frequency of forked root-hair in different species of *Saccharum*

Species	No. of clones studied	Mean frequency of forked root-hair %
<i>S. officinarum</i>	72	2.70
<i>S. barberi</i>	46	15.56
<i>S. sinense</i>	12	18.34
<i>S. spontaneum</i>	84	0.46
<i>S. robustum</i>	26	3.56
<i>S. officinarum</i> × <i>S. spontaneum</i> (experimental hybrids)	27	15.29

C.D. at 5% level—5.28.

The pattern of forking frequency within the genus raises points of phylogenetic and metabolic interests. The three species *S. officinarum*, *S. robustum* and *S. spontaneum* are alike with low forking frequency, while the other two closely related species *S. barberi* and *S. sinense* stand out for their high frequency of forked root-hairs. Members of these two species, collectively known as the indigenous 'North-Indian canes' are believed to have originated through promiscuous hybridization between *S. officinarum* and *S. spontaneum*.<sup>2</sup> The high degree of root-hair forking exhibited by the experimental hybrids between *S. officinarum* and *S. spontaneum* lend support to the above hypothesis.

Boysen Jensen<sup>3</sup> cited by Cormack<sup>4</sup> achieved chemical induction of root-hair branching in *Lepidium*, *Sinapis* and *Phleum* and suggested that the phenomenon is the outward manifestation of metabolic antagonism within the cell. The putative parents of the North-Indian canes are known to differ in their metabolism and in their rooting pattern. The accentuation of root-hair forking in the two species, *S. barberi* and *S. sinense* could be probably due to the boosted production of certain substance(s) as a consequence of hybridizing alien metabolic patterns.

Sugarcane Breeding Institute,  
Coimbatore-7, August 28, 1968.

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B. V. NATARAJAN.

1. Dittmer, H. J., 1949, *Amer. J. Bot.*, 36, 152.
2. Parthasarathy, N., *J. Ind. Bot. Soc.*, M. O. P. Iyengar Comm. Vol., 1946, 133.
3. Boysen Jensen, P., *Tatigist. K. Danske Vidensk. Selsk. Biol. Medd.*, 1955, 18, 1 (original not seen).
4. Cormack, R. G. H., *Bot. Rev.*, 1962, 28, 449.

## REVIEWS AND NOTICES OF BOOKS

**Electrolyte Theory** (*An Elementary Introduction to a Microscopic Approach*). By Pierre M. V. Resibois. (Harper and Row, Publishers, 49, East 33rd Street, New York-16, N.Y.), 1968. Pp. x + 166. Price \$11.25.

This book introduces the student to many concepts of theoretical physical chemistry in a concrete and particularly important field of application: equilibrium and non-equilibrium properties of electrolytes. Principles of statistical mechanics are applied to give the student an understanding of electrolyte theory up to the point where formulas may be checked experimentally.

Emphasis is on methods and approximations rather than on the results themselves. For example, no comparison is made between theory and the enormous amount of available experimental data, but much attention is given to Brownian motion theory (as an approximation of the motion of ions in solution) both from the classical and from the microscopic points of view.

The contents of this book are: Introductory Survey; Introduction to Equilibrium and Non-equilibrium Statistical Mechanics; Equilibrium Properties of Dilute Electrolyte Solutions; Brownian Motion; Limiting-Law Transport Properties; and Survey of Alternative Approaches.

C. V. R.

**Analysis I.** By Serge Lang. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London W. 1, England), 1968. Pp. xi + 460. Price 72 sh.

The present volume is a text designed for a first course in analysis. Although it is logically self-contained, it presupposes the mathematical maturity acquired by students who will ordinarily have had two years of calculus. When used in this context, most of the first part may be omitted or reviewed extremely rapidly. The course can proceed immediately into Part Two after covering Chapters O and I.

The chapters contained in this volume are: Part One: Sets and Mappings; Real Numbers; Limits and Continuous Functions; Differentiation; Elementary Functions; The Elementary Real Integral; Part Two: Convergence-Normed Vector Spaces; Limits; Compactness; Series;

The Integral in One Variable. Part Three: Applications of the Integral: Approximation with Convolutions; Fourier Series; Improper Integrals; The Fourier Integral. Part Four: Calculus in Vector Spaces-Functions on  $n$ -space; Derivatives in Vector Spaces; Inverse Mapping Theorem; Ordinary Differential Equations; and Part Five: Multiple Integration-Multiple Integrals and Differential Forms.

C. V. R.

**Introduction to Modern Biochemistry.** (Third Edition). By Karlson. Academic Press, Inc., New York and London, 1968. Pp. xix + 483. Price \$11.75.

Based on the two latest German editions, this revision of Professor Karlson's successful text-book presents the latest trends and insights in biochemical studies. The chapter on proteins has been reworked, and the dynamic aspect of protein structure, particularly allosteric changes, has been emphasized. The entire genetic code is now included in the chapter on nucleic acids, and new material on the origin of life has been added. Other new features include a strengthened treatment of enzyme kinetics and metabolism control; expanded chapters on intermediary metabolism, hormones and photosynthesis; improved classification of RNA; the utilization of the R-S system of designating stereo-chemical configuration. There are approximately 30 new illustrations.

C. V. R.

**Annual Review of Plant Physiology** (Vol. 19). Edited by Leonard Machlis. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1968. Pp. viii + 555. Price \$8.50 in U.S.A. and \$9.00 elsewhere.

Volume 19 of this well-known series contains the following articles: Prefatory Chapter: Internal Factors of Plant Flowering, by Mikhail Kh. Chailakhyan; Cell Structure and Function: RNA Structure and Metabolism; Mineral Nutrition: Micro-organisms and the Inorganic Nutrition of Higher Plants; Mineral Nutrition of Algae; Iron Compounds and Plant Nutrition; Nitrogen Metabolism: Occurrence in Plants of Amino-Acid Residues Chemically Bound

Otherwise than in Proteins; Photosynthesis: Photophosphorylation in Chloroplasts; Hæm-Proteins in Photosynthesis; Electron Transport Pathways in Photosynthesis; EPR Studies of Free Radicals in Photosynthetic Systems; Respiration: Electron Transport in Respiration; General Metabolism: Plant Isoenzymes; Polyketide Metabolism; Water Relations: Transpiration and Leaf Temperature; Absorption and Translocation: Salt Absorption by Plants; Growth and Development: The Transport of Auxin; Control of Differentiation in Fern-Allies and Bryophytes; Rhythmic Processes in Plants; The Physiology of Tendrils; Ultrastructure and Physiology of Pollen; and Stress Physiology: Ionizing Radiations as Research Tools and Special Topic: Evaluation of Visible Radiation for Plant Growth. C. V. R.

**Transistor Physics and Circuits.** By M. P. Ristenbatt and R. L. Riddle. (Second Edition.) (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1). Pp. 549. Price not given.

The original English edition of this textbook was published by Prentice-Hall. This second edition of the book, by American authors, and printed in Japan, is issued as the first Indian edition. It has been extensively revised and updated. A new chapter on the circuit aspects of field effect transistors has been added. The physics of transistors and elements of transistor theory and circuit analysis are explained in the beginning, and the student is progressively taken to complicated principles and applications, emphasizing performance, calculations and design procedures. The book gives a practical approach to the subject, and includes a number of problems. A. S. G.

**Fatty Acids and Their Industrial Applications.** Edited by E. Scott Pattison. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y., 10016), 1968. Pp. 390. Price \$ 8.00.

This multi-author publication gives the latest information on the chemistry and applications of fatty acids in industry today. 19 authors connected with the chemistry, production and industrial applications of fatty acids have con-

tributed to the 17 chapters in the book. Applications deal with soap and detergent, cosmetics, rubber, textile, pharmaceutical, food, and coatings industries. The publication provides an important informative text for industrial and potential users of fatty acids.

A. S. G.

**Commercial Vegetable Growing.** By H. D. Tindall. (Oxford University Press, Mount Road, Madras), 1968. Pp. 300. Price Rs. 27 or 30 sh.

This paperback hand-book gives useful and essential information on various kinds and varieties of vegetables which can be successfully grown in tropical countries on a commercial scale. Although many of the operations used in traditional vegetable-growing areas are still carried out by hand, the author refers to modern techniques, especially machinery for soil preparation and the irrigation of crops, which can be profitably adopted by commercial growers. The text deals with various aspects of vegetable-growing, and includes economics, site selection and preparation, cultivation methods, fertilizers, pests and diseases, insecticides, etc. A very useful book indeed for vegetable growers. A. S. G.

#### Books Received

**Ideas in Mathematics.** By M. E. Munroe. (Addison-Wesley Pub. Co., West End House, 11, Hills Place, London W. 1), 1968. Pp. vii + 264. Price 59 sh.

**Sets, Functions and Probability.** By J. B. Johnston, G. B. Price and F. S. Van Vleck. (Addison-Wesley Pub. Co., London W. 1), 1968. Pp. viii + 376. Price 89 sh.

**Probability.** By Leo Breiman. (Addison Wesley Pub. Co. Inc., West End House, 11, Hills Place, London W. 1), 1968. Pp. ix + 421. Price 126 sh.

**Progress in Analytical Chemistry (Vol. 1)—X-Ray and Electron Methods of Analysis.** Edited by H. van Olphen and W. Parrish. (Plenum Press, 227, W. 17th St., New York, N.Y. 10011), 1968. Pp. x + 164. Price \$ 12.50.

**AAS Science and Technology Series. Vol. 14. Interpretation of Lunar Probe Data.** Edited by Jack Green. (American Astronautical Society Publications Office, P.O. Box No. 746. Pp. xiv + 256.

## PLANE DICHROMATIC SPACE GROUPS

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THE ordinary crystallographic theory in two dimensions, making use of anti-symmetry operations, was first extended by Alexander and Hermann<sup>1,2</sup> (1928, 1929) when the possible symmetries of liquid crystals are studied. Starting from the 17 two-dimensional conventional space groups they derived 80 space groups when both sides of a plane are regarded as distinct. These 80 groups can be divided into three categories, namely, (i) the ordinary 17 space groups, (ii) the 17 grey space groups containing the anti-identity operation explicitly and (iii) the 46 double-coloured (dichromatic) magnetic space groups which can also be designated as the magnetic variants of the space groups. Cochran<sup>3</sup> in order to describe fully the symmetry properties of real periodic functions in two dimensions employed in crystallography has enumerated these 46 dichromatic space groups with the help of the six reversal symmetry operations. Further references concerning the methods of derivation of the magnetic space groups in a plane are to be found in the review article of Mackay.<sup>4</sup> In this note the 46 magnetic double-coloured space groups are derived from the representation theory of the conventional space groups employing the method indicated earlier by the authors (Krishnamurty and Gopalakrishnamurty).<sup>5</sup> Several interesting features noted in the course of the derivation of the magnetic variants of the space groups in a plane are described here in detail.

### A BRIEF OUTLINE OF THE METHOD

It has already been pointed out by the authors<sup>5</sup> that the magnetic variants of a space group can be obtained from the non-equivalent alternating representations of the symmorphic (point) space group, which is reciprocal to the underlying point space group of the given space group. For instance, the underlying point space group of *pmg* and *pgg* in two dimensions is *pmm* and its reciprocal point space group is *pmm* itself. Thus one may infer that the magnetic variants of all those conventional space groups having the same underlying space group can be derived from the alternating representations of the symmorphic space group which is reciprocal to that underlying space group. Though the

alternating representations of the reciprocal symmorphic space group, no doubt, induce the magnetic variants of a space group, yet in enumerating the magnetic variants, the distinct features of the symmetry elements of the given space group have to be taken into account in deciding the equivalence among the inducing alternating representations. Since the only lattices encountered in two dimensions are either primitive (*p*) or side-centered (*c*), it is sufficient to note that if a crystal lattice is primitive or side-centered, its reciprocal lattice is primitive or side-centered.

If  $T_x$  and  $T_y$  are the basic translations along the Bravais axes in two dimensions,  $T_x$  and  $T_y$  can be represented (Koster<sup>6</sup>) respectively by  $\exp. (2\pi i k_x)$  and  $\exp. (2\pi i k_y)$ , where  $k_x$  and  $k_y$  are the components of the wave-vector  $\vec{k}$  belonging to the reciprocal space. It is enough (Krishnamurty and Gopalakrishnamurty<sup>7</sup>) to consider the equations  $T_x^2 = T_y^2 = E$  (identity) in enumerating the magnetic variants of a space group. This restricts the choice of the admissible values of the  $k_x$  and  $k_y$  to either 0 or  $\frac{1}{2}$ . Hence in the construction of the dichromatic magnetic space groups in two dimensions we need consider only those stars containing any one (Krishnamurty and Gopalakrishnamurty<sup>8</sup>) of the wave vectors:  $(0,0)$ ,  $(0,\frac{1}{2})$ ,  $(\frac{1}{2},0)$  and  $(\frac{1}{2},\frac{1}{2})$  from the 13 distinct reciprocal point space groups in terms of whose alternating representations, the magnetic variants of the 17 conventional space groups can be derived.

### CLASSIFICATION OF SPACE GROUPS

The alternating representations of a crystallographic space group can be enumerated by considering the generating elements of the space group. The maximum number of the generating elements of a conventional space group in two dimensions will be 4 and their characters in the alternating representations will be  $\pm 1$ . An alternating representation of an ordinary space group in which the characters of  $T_x$  and  $T_y$  are alone equal to  $-1$  will induce a dichromatic magnetic space group hereafter designated as a point group variant of the space group. The dichromatic space groups induced by the alternating representa-

tions, which correspond to the distinct stars containing a non-zero wave vector, of the reciprocal symmorphic space group, are referred to as translational group variants of the space group. Further one may easily see that if all the generating elements are represented by the character  $+1$  in an irreducible representation of a space group, then the corresponding induced magnetic space group cannot be distinguished from the given conventional space group. For purposes of enumeration of the double-coloured magnetic space groups, it is found convenient to express them as the sum of the two kinds of the variants: (i) the point group variants and (ii) the translational group variants. Thus in what follows the conventional space groups in two dimensions are accordingly divided into two categories.

#### DERIVATION OF THE PLANE DICHROMATIC SPACE GROUPS

For convenience and purposes of clarity the 17 two-dimensional space groups are classified hereunder into two categories, namely, I:  $p1$ ,  $p2$ ,  $p4$ ,  $p3$ ,  $p3m1$ ,  $p31m$ ,  $p6$  and II:  $pm$ ,  $pg$ ,  $cm$ ,  $pmm$ ,  $pmg$ ,  $pgg$ ,  $cmg$ ,  $p4m$ ,  $p4g$  and  $p6m$ . It is well known that the point group symmetries of the 17 space groups belong to one or other of the 10 crystallographic point groups in two dimensions. The number of the double-coloured magnetic point groups corresponding to each one of the 10 ordinary point groups in a plane is given below in brackets against the appropriate point group: 1 (0); 2(1); 4(1); 3(0); 3m (1); 6(1); m (1); 2mm (2); 4mm(2) and 6mm(2). The magnetic variants of the 7 plane space groups of category I whose underlying point groups are 1, 2, 4, 3, 3m and 6 have been enumerated and expressed in Table I directly as the sum of the point group variants and the translational group variants of the space groups.

TABLE I

No.	Space group	Lattice	No. of point group variants	No. of translational group variants	No. of induced dichromatic magnetic space groups
1	$p1$	Monoclinic	0	1	1
2	$p2$	"	1	1	2
3	$p4$	Tetragonal	1	1	2
4	$p3$	Hexagonal	0	0	0
5	$p3m1$	"	1	0	1
6	$p31m$	"	1	0	1
7	$p6$	"	1	0	1
Total ..			5	3	8

In this way, the 8 dichromatic magnetic variants of the 7 space groups of category I are described.

The point groups of the remaining 10 two-dimensional space groups belonging to category II are  $m$ ,  $2mm$ ,  $4mm$  and  $6mm$ . The double-coloured magnetic space groups of  $pmm$ ,  $pmg$  and  $pgg$  classified under category II will now be considered in detail. For the above three space groups, the underlying point space group is  $pmm$ , whose reciprocal space group is  $pmm$  itself as has been mentioned earlier. It will now be shown that the double-coloured magnetic space groups associated with  $pmg$  and  $pgg$  can be obtained from the alternating representations of  $pmm$ . The generating elements of  $pmm$  may be taken as  $\sigma_x$ ,  $\sigma_y$ ,  $T_x$  and  $T_y$ .

The 16 one-dimensional real irreducible representations of  $pmm$  can be uniquely described by the relations:

$$\sigma(\sigma_x) \rightarrow \pm 1, \sigma'(\sigma_y) \rightarrow \pm 1, T(T_x) \rightarrow \pm 1 \text{ and } T'(T_y) \rightarrow \pm 1.$$

The character Table of  $pmm$  constructed in terms of the 4 generating elements is given in next page.

Taking isomorphism among the subgroups of index 2 associated with the 15 irreducible representations of  $pmm$  into account, the 15 alternating representations of  $pmm$  are grouped into the following classes so far as the derivation of the dichromatic magnetic space groups of  $pmg$  is concerned: (i)  $A_5$ ,  $A_6$ ,  $A_9$ ,  $A_{10}$ ; (ii)  $A_7$ ,  $A_8$ ,  $A_{11}$ ,  $A_{12}$ ; (iii)  $A_{13}$ ,  $A_{14}$ ,  $A_{15}$ ,  $A_{16}$ ; (iv)  $A_2$ ; (v)  $A_3$  and (vi)  $A_4$ . Here the alternating representations in a class are equivalent. It may be noted that in the case of  $pmg$ ,  $\sigma$  cannot be regarded as equivalent (isomorphous) to  $\sigma'$  since the latter is a glide plane while the former is a mirror plane. Establishment of isomorphism among the associated subgroups of index 2 is facilitated by noting that the basic translations  $T$  and  $T'$  of the orthorhombic primitive lattice can be interchanged which means the equivalence<sup>5</sup> of the stars  $b$  and  $c$  of the space group  $pmm$ . The non-equivalent alternating representations of  $pmm$  corresponding to the classes (i), (ii) and (iii) induce the magnetic double-coloured space groups called the translational group variants, while those corresponding to the classes (iv), (v) and (vi) induce the magnetic variant space groups referred to as the point group variants. Thus the total number of the dichromatic magnetic space groups associated with  $pmg$  is 6. The



Character table of  $pmm$

Star	Irreducible representations	$\sigma$	$\sigma'$	T	T'	Associated* subgroups of index 2	Rational symbol (Shubnikov and Belov <sup>9</sup> ) of the induced dichromatic space groups
$a(0,0)$	$A_1$	1	1	1	1	$H_2(\sigma, T, T')$	$\dots$
	$A_2$	1	-1	1	1	$H_3(\sigma', T, T')$	$\dots$
	$A_3$	-1	1	1	1	$H_4(\sigma\sigma', T, T')$	$\dots$
	$A_4$	-1	-1	1	1	$H_5(\sigma\sigma', T', T)$	$\dots$
$b(0, \frac{1}{2})$	$A_5$	1	1	1	-1	$H_6(\sigma, \sigma'T, T)$	$\dots$
	$A_6$	1	-1	1	-1	$H_7(\sigma', T, \sigma T')$	$\dots$
	$A_7$	-1	1	1	-1	$H_8(\sigma T', \sigma'T', T)$	$\dots$
	$A_8$	-1	-1	1	-1	$H_9(\sigma, \sigma', T')$	$\dots$
$c(\frac{1}{2}, 0)$	$A_9$	1	1	-1	1	$H_{10}(\sigma, \sigma'T, T')$	$\dots$
	$A_{10}$	1	-1	-1	1	$H_{11}(\sigma', T', \sigma T)$	$\dots$
	$A_{11}$	-1	+1	-1	1	$H_{12}(\sigma T, \sigma'T, T')$	$\dots$
	$A_{12}$	-1	-1	-1	1	$H_{13}(\sigma, \sigma', TT')$	$\dots$
$d(\frac{1}{2}, \frac{1}{2})$	$A_{13}$	1	1	-1	-1	$H_{14}(\sigma, \sigma'T, TT')$	$\dots$
	$A_{14}$	1	-1	-1	-1	$H_{15}(\sigma', \sigma T', TT')$	$\dots$
	$A_{15}$	-1	1	-1	-1	$H_{16}(\sigma T, \sigma T', TT')$	$\dots$
	$A_{16}$	-1	-1	-1	-1		$\dots$

\* The symmetry elements given in brackets against a subgroup of index 2 in this table are the generating elements of the subgroup.

double-coloured magnetic space groups of  $pmm$  can be deduced from those of  $pmg$  by ignoring the fractional translation present in  $\sigma'$  of  $pmg$  and hence treating  $\sigma$  and  $\sigma'$  to be equivalent. From this, the classes (i) and (ii), (iv) and (v) can be clubbed together to give rise to only four distinct classes. Consequently, four dichromatic magnetic space groups correspond to  $pmm$ .

The magnetic variants of the space group  $pgg$  stand on equal footing with those of  $pmm$  since fractional translations are involved in both the reflection planes of  $pgg$ . The remaining space groups of category II can be treated on similar lines and the results so obtained concerning the 10 space groups of the second category are summarised in Table II.

The 46 magnetic variants of the two-dimensional space groups so enumerated are given in Tables I and II.

#### DISCUSSION

It may be interesting to note that in the case of the two-dimensional space groups  $p4m$  and  $p6m$  the number of the double-coloured magnetic space groups (Table II) described here as the point group variants is 3, whereas the number of the magnetic variants of the respective underlying point groups  $4mm$  and  $6mm$  is 2 only. This is because the equivalence between  $2\sigma_p$  and  $2\sigma_p'$  of  $4mm$ ,  $3\sigma_p$  and  $3\sigma_p'$  of  $6mm$  (Bhagavantam and Venkatarayudu<sup>10</sup>) present in the point

TABLE II

No.	Space group	Lattice	No. of point group variants	No. of translational group variants	Total no. of the induced dichromatic space groups
1	$pm$	Orthorhombic	2	2	4
2	$pg$	"	2	2	4
3	$cm$	"	1	1	2
		side-centered			
4	$pmm$	Orthorhombic	2	2	4
5	$pmg$	"	3	3	6
6	$pgg$	"	2	2	4
7	$cmg$	"	2	1	3
		side-centered			
8	$p4m$	Tetragonal	3	1	4
9	$p4g$	"	3	1	4
10	$p6m$	Hexagonal	3	0	3
Total			23	15	38

groups is destroyed by the translations of the space group. The translations in a space group will be responsible for the non-equivalence of two conventional symmetry operations which are otherwise regarded as isomorphous (equivalent) in the underlying point group. One may also add that the double-coloured magnetic variants of a crystallographic space group referred to here as the point group variants are induced by the alternating representations of the factor group of the reciprocal point space group.

The authors wish to express their grateful thanks to Prof. T. Venkatarayudu for the helpful discussions which they had with him on the problem.

1. Alexander, E. and Hermann, K., *Z. Kristall.*, 1928, **69**, 285.
2. — and —, *Ibid.*, 1929, **70**, 328.
3. Cochran, W., *Acta Cryst.*, 1952, **5**, 630.
4. Mackay, A. L., *Ibid.*, 1957, **10**, 543.
5. Krishnamurty, T. S. G. and Gopalakrishnamurty, P., "Dichromatic Shubnikov space groups," *Curr. Sci.*, 1968, **37**, 638.
6. Koster, G., *Solid State Physics*, 1957, **5**, 173.
7. Krishnamurty, T. S. G. and Gopalakrishnamurty, P., A paper on "Magnetic Symmetry Groups," Communicated to *Acta Cryst.*, 1968.
8. — and —, "A note on the derivation of magnetic lattices" *Curr. Sci.*, 1968, **37**, 574.
9. Shubnikov, A. V. and Belov, N. V., *Coloured Symmetry*, Pergamon Press, Oxford, 1964, p. 214.
10. Bhagavantam, S. and Venkatarayudu, T., *Theory of Groups and its Applications to Physical Problems*, Andhra University, 1951, p. 124.

### A METHOD FOR THE ESTIMATION OF TOTAL SOLUBLE COBALT IN SEA-WATER\*

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THE estimation of cobalt in sea-water has been done by various workers<sup>1-4</sup> using colorimetry and activation analysis methods. In view of the extremely low content of cobalt in sea-water (0.1–1.0 µg./l), co-precipitation methods have been used for preliminary concentration of the element. Yamagata and Iwashima<sup>5</sup> added powdered manganese dioxide to sea-water which scavenges cobalt along with other trace elements. The recoveries are established to be 100% using cobalt-60 in the chloride form as tracer. Krishnamoorthy and Viswanathan<sup>4</sup> have co-precipitated cobalt along with magnesium hydroxide by adding KOH solution to sea-water and the recoveries are established to be 93% using cobalt-58 in the chloride form as tracer.

Cobalt is one of the biologically active elements which is taken up by the phytoplankton and algæ from sea-water. Preliminary laboratory studies<sup>6</sup> indicated that cobalt can be associated in significant amounts with soluble organic matter. From the work reported in the literature, it is not established whether cobalt associated with soluble organic matter is also carried in the initial concentration steps used. Experiments have been carried out to find whether any differences exist in the recovery of cobalt if it is present in the ionic form as well as in the organic form.

Three litres of sea-water filtered through Whatman No. 42 filter-paper is spiked with Co<sup>58</sup>Cl<sub>2</sub> tracer and magnesium is precipitated as hydroxide using 10 ml. of 4N NaOH. Cobalt-58 gamma activity in the precipitate is counted and compared with the standard added. The recoveries are found to be 96–98% and these results are given in Table I.

TABLE I  
Co-precipitation of cobalt-58 with magnesium hydroxide

No.	Co-58 activity in solution after 40 hrs. equilibration cpm	Co-58 activity in Mg (OH) <sub>2</sub> ppt. cpm	Activity in supernatant liquid (before filtration) cpm	Activity in supernatant liquid (after filtration) cpm
1	106,652	102,500 (96%)	1875 (1.8%)	1200 (1.2%)
2	108,000	105,600 (98%)	656 (0.7%)	488 (0.5%)

Activity of cobalt-58 added to the solution 106,700 cpm.

*Chlorella* sp. is grown in sea-water spiked with Co<sup>60</sup>Cl<sub>2</sub> tracer to get organically bound cobalt.<sup>6</sup> The supernatant of the culture solution is filtered through 0.22 µ millipore membrane filter. An aliquot of the culture solution containing soluble cobalt (organically bound and/or otherwise) is added to 3 litres of filtered sea-water and magnesium is precipitated as hydroxide as above. The precipitate is allowed to settle for 2 hours and the supernatant liquid decanted. The slurry

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contents of hydroxide precipitate is centrifuged and precipitate dissolved in 50 ml. of 6 N HCl. The solution is evaporated to dryness, taken up in 10 ml. of water and cobalt-60 activity is measured by gamma counting (3% standard deviation). The sample and standard activities are counted under the same conditions of volume and geometry for comparison. In the supernatant liquid, second and third magnesium hydroxide precipitations are carried out and the slurry is treated and counted as above. The data are summarised in Table II.

TABLE II

*Co-precipitation of organically bound cobalt with magnesium hydroxide*

Expt. No.	Process	Co-60 activity		Recovery %
		Added cpm	Recovered cpm	
1	First Mg(OH) <sub>2</sub> precipitation	438	195	44.5
	Second Mg(OH) <sub>2</sub> precipitation	..	127	29.0
	Third Mg(OH) <sub>2</sub> precipitation	..	23	5.3
	Total	..	..	78.8
2	First Mg(OH) <sub>2</sub> precipitation	438	185	42.0
	Second Mg(OH) <sub>2</sub> precipitation	..	130	29.1
	Third Mg(OH) <sub>2</sub> precipitation	..	27	6.2
	Total	..	..	77.3

As seen from Table II, the first hydroxide precipitate is carrying down only 43% of the total cobalt-60 activity whereas the second and third precipitates carry 29% and 5.7% respectively. The experiment demonstrates that 96-98% recoveries obtained by spiking the system with ionic tracers are not applicable when cobalt can be present as organically bound in the system.

In view of the above, the following experiments are conducted to release the organically bound cobalt into ionic form so that all the cobalt can be co-precipitated in the initial concentration step.

To 3 litres of filtered sea-water is added 1 ml. cobalt-60 culture filter solution. Oxidising agents such as saturated bromine water, KMnO<sub>4</sub> in neutral medium and K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> in sulphuric acid medium are added and oxidations carried out under different conditions. The percent recoveries by single co-precipitation step are determined as earlier and the results are summarised in Table III.

As seen from Table III, saturated bromine water and potassium permanganate in neutral

TABLE III  
*Recovery of cobalt-60 from Chlorella sp. culture filtrate with various oxidising agents*

Expt. No.	Oxidation process	Carrier precipitate	Co-60 culture activity		Recovery %
			Added cpm	Recovered cpm	
1	50 ml. of saturated bromine water, heated for 30 mts.	Mg(OH) <sub>2</sub>	243	197	82.0
2	do.	.. Mg(OH) <sub>2</sub>	243	209	85.8
3	75 ml. of saturated bromine water, heated for 2 hrs.	Mg(OH) <sub>2</sub>	256	218	85.1
4	do.	.. Mg(OH) <sub>2</sub>	256	208	82.1
5	50 ml. of saturated bromine water, 30 mts. heating, 500 mg. cf iron added	Fe(OH) <sub>3</sub> and Mg(OH) <sub>2</sub>	185	167	84.9
6	do.	.. Fe(OH) <sub>3</sub> and Mg(OH) <sub>2</sub>	185	156	84.8
7	1 ml. of 5% KMnO <sub>4</sub> , heated for 1 hr. and 0.2 gm. MnCl <sub>2</sub> added	MnO <sub>2</sub>	375	320	85.4
8	do.	MnO <sub>2</sub>	375	307	82.0
9	7.5 gm. of K <sub>2</sub> S <sub>2</sub> O <sub>8</sub> and 20 ml. of conc. H <sub>2</sub> SO <sub>4</sub> , boiled for 2 hrs.	Mg(OH) <sub>2</sub>	300	303	101.0
10	do.	.. Mg(OH) <sub>2</sub>	150	147	98.0
11	do.	.. Mg(OH) <sub>2</sub>	150	148	98.7

medium are not very effective oxidising agents (oxidation  $\leq$  85%). On the other hand, potassium persulphate in sulphuric acid medium is quantitative in oxidising capacity.

These observations indicate that it is necessary to use the oxidising agent potassium persulphate in sulphuric acid medium prior to any initial concentration and subsequent processing.

Our thanks are due to Dr. A. K. Ganguly for suggesting this work. Thanks are also due to Shri M. V. M. Desai and Kum. Elizabeth Koshy for giving us the *Chlorella* sp. grown in Co<sup>60</sup> medium.

1. Weiss, H. P. and Reed, J. A., *J. Mar. Res.*, 1959, **18**, 186.
2. Schutz, D. F. and Turekian, K. K., *J. Ceophys. Res.*, 1965, **70**, 5519.
3. Doshi, G. R., *Ind. Jour. Chem.*, 1967, **5**, 580.
4. Krishnamoorthy, T. M. and Viswanathan, R., *Ibid.*, 1968, **6**, 169.
5. Yamagata, N. and Iwashima, K. K., *Nature*, 1953, **200**, 52.
6. Koshy, E., "Organic materials in the marine environment and their interaction with some metal ions," *M.Sc. Thesis*, Bombay University, 1968.

## ON THE CLASSIFICATION OF CERTAIN ANGIOSPERMOUS STOMATA

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**C**LASSIFICATION of stomata has been attempted by several workers in the past.<sup>1</sup> Of the different systems proposed, Pant's<sup>1</sup> is the most comprehensive one, as it accords a place for all the stomatal types so far known. On the basis of ontogeny, Pant divides the angiospermous stomata into three major categories: (i) the mesogenous in which the subsidiary cells are derived from the meristemoid itself, (ii) the mesoperigenous in which one of the subsidiary cells is mesogenous, while the others are perigenous and (iii) the perigenous where the meristemoid directly divides into the guard cells. We have been investigating stomatal ontogeny of a number of Cucurbitaceae (more than thirty species) and Compositae (over fifty species) wherein certain patterns of stomatal development have been observed which are different from those taken into account by Pant in his classification. These patterns are, however, not radically different from those considered by Pant; they fit into his scheme if it is suitably elaborated. The ontogeny of foliar stomata of two members, *Tagetes patula* L. (Compositae) and *Cucumis pubescens* Willd. (Cucurbitaceae) will be described below to exemplify the said stomatal types. The terms used are as defined by Pant.

*Cucumis pubescens* L.—The stomata are mostly anomocytic (ranunculaceous) being surrounded by 3-5 cells nearly of the same size and similar to the adjacent epidermal cells (Fig. 8, S). Some of them, however, show one of the subsidiary cells smaller than the others (Fig. 8, S<sub>1</sub>) or tend to be anisocytic (cruciferous) (Fig. 8, S<sub>2</sub>). The stomata are diffuse in their distribution and borne on the leaf, stem, bract, sepals, petals and on the ovary outer surface. Their frequency on the leaf is given in Table I.

TABLE I  
Leaf stomatal distribution per mm.<sup>2</sup>

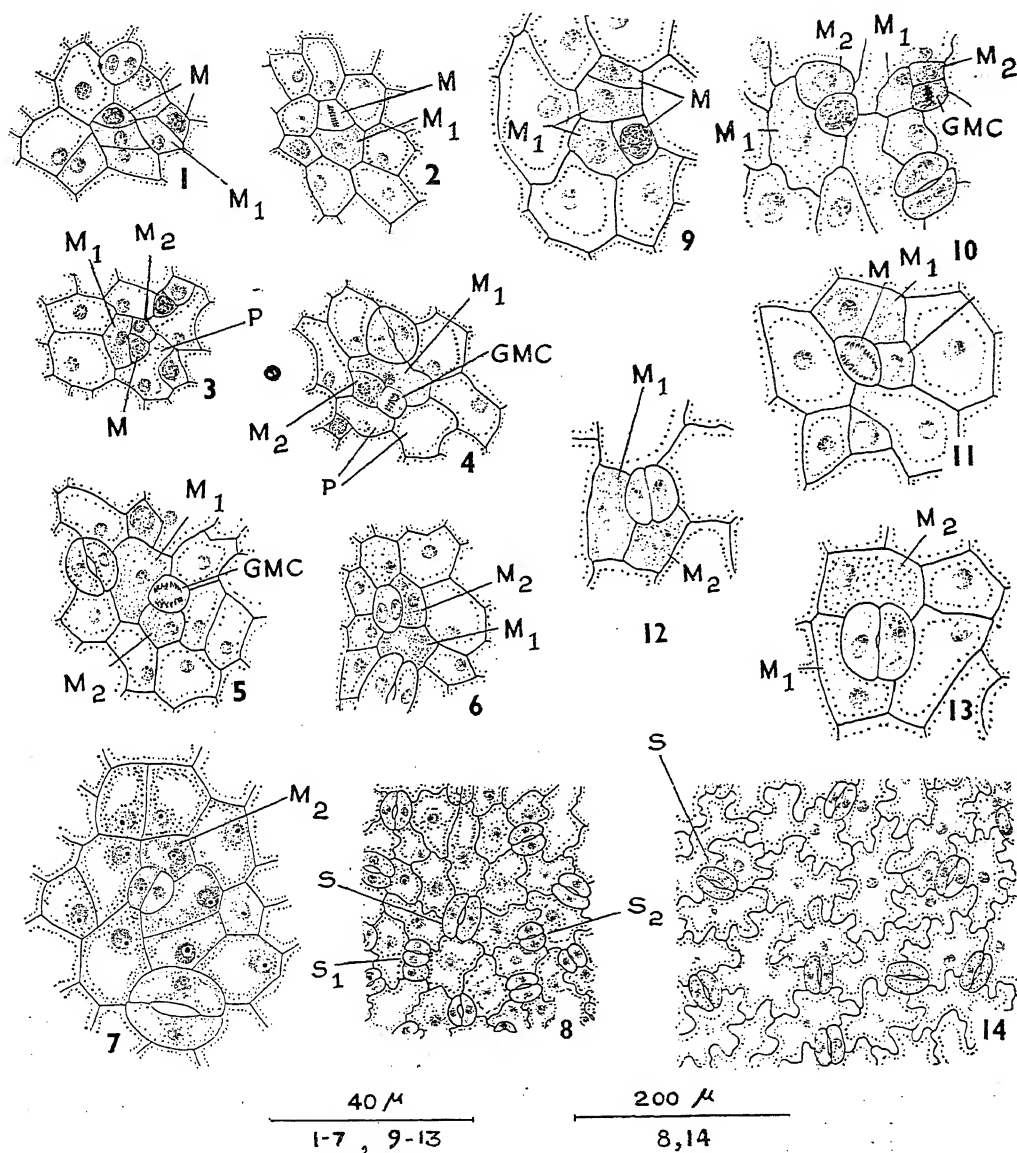
Name	Lower surface			Upper surface		
	Prox.	Middle	Distal	Prox.	Middle	Distal
<i>Cucumis pubescens</i>	585	610	600	253	300	250
<i>Tagetes patula</i> ..	180	135	155	120	95	105

Single protodermal initials or meristemoids (M) give rise to the stomata. They, however, divide so early that the first recognisable stage is always accompanied by a mesogenous subsidiary cell (M1) (Fig. 1). The latter is distinguished due not only to its juxtaposition with the meristemoid, but by its relatively smaller size, denser contents and less vacuolated condition as compared with the adjacent epidermal cells. The meristemoid soon cuts off a second mesogene cell (M2) which lies at about 90° to the first one (Figs. 2 and 3). As seen from the figures, the sequence of the two anticlinal divisions may be clockwise (Fig. 3) or anticlockwise (Fig. 4). Of the two subsidiary cells, the M2 is often retarded in development (Fig. 7) and hence becomes small-sized which forms the smaller subsidiary cell found in some of the stomata of the species referred to earlier. The subsidiary cells lying towards the non-cutting face of the meristemoid are of the perigenous type which may be one (Fig. 3, p) or more (Fig. 4, p) in number. The meristemoid, after giving off the two mesogene cells, acts as the guard cell mother cell (GMC) (Figs. 4 and 5). The GMC becomes nearly rounded in outline before dividing into the guard cells (Figs. 4 and 5). The angle of division of the GMC, in relation to the partition cutting off the second mesogene is, however, variable (Figs. 4-6). Since this feature is important in classifying the stomata, the stomatal variants recognisable on this basis have been determined which are as follows. Stomata in which GMC division in relation to the second partition is (1) parallel (Fig. 4), (2) at right angle (Fig. 7; see also Fig. 10) and (3) at any angle (Fig. 5). (These can also be recognised in relation to the first mesogene M1.) Since in certain stomatal forms of the species, the M2 is distinctive by its smaller size, its angular variance with the division of the GMC or *vice versa* can be followed even in mature stomata (see for example stomata S<sub>1</sub> and S<sub>2</sub> in Fig. 8).

*Tagetes patula* L.—The stomata are of the same kind as observed in *Cucumis pubescens*, but occasional ones are also anisocytic

(Fig. 14, S). They are diffuse in their distribution and occur on the stem, both the surfaces of leaf, bracts and corolla and externally

of the GMC with the second partition also shows the same three variations (Figs. 10 and 11) excepting that the parallel type is far



FIGS. 1-14. Figs. 1-7. *Cucumis pubescens*: Developmental stages (Figs. 1-7) and mature stomata (Fig. 8) from the leaf lower epidermis. Figs. 9-14. *Tagetes patula*: Developmental stages of stoma (Figs. 9-13) and mature stomata (Fig. 14) from the leaf lower epidermis. (For abbreviations used see the text.)

on the ovary. Their frequency of distribution on the leaf is given in Table I. Their ontogeny is similar (see Figs. 9-13) as observed in *Cucumis pubescens* and the angle of division

infrequent. Stomata of this kind have been also reported in *Piper betle* earlier,<sup>2</sup> but an analysis of only the right-angled type was considered.

From the description it is obvious that in both the species the stomata possess two mesogenous subsidiary cells and others of the perigenous type. Therefore, these come under the mesoperigenous category of Pant. In this category Pant distinguishes three stomatal types (see below) all of which are characterised by only one mesogenous subsidiary cell unlike the present ones which show two such cells.

Pant found two characters useful in subclassifying his main stomatal categories: one, the number of cutting faces of the stomatal meristemoids and second, the angle of GMC division with the preceding partition. Accordingly he divides the mesogenous stomata into unilabrate, dolabrate, trilabrate and tetralabrate types depending upon their number of cutting faces. Of these, the dolabrate stomata are further divided into the mesoparacytic, mesodiacytic and pyrosia type on the basis of the angle of GMC division with the preceding one. An analysis of the mesoperigenous stomata including the types recognised by Pant and those presently described shows that they can also be classified in the same manner. Therefore, a revised classification of the mesoperigenous stomata along with their earlier treatment by Pant is given below.

of the plane of division of the GMC with the mesogenous subsidiary cell as shown above.

**Dolabrate Types.**—This category is proposed for the types described by the present authors. Since the meristemoid of these stomata has two cutting faces, they are designated as dolabrate type. As shown above they can be distinguished from each other on the basis of the orientation of the division of the GMC with the partition giving the second subsidiary cell. Pant named the unilabrate stomatal types after species names, but this practice has not been preferred here, as the stomata described occur side by side. It is obvious that the stomata showing the GMC division at any angle represent transitional forms between the right angle and the parallel types.

In both the families studied, the right angle type of stoma is more frequent than the others. Taxonomically the dolabrate stomatal types are not found to be of value in the two families as they occur in the same plant, though this does not preclude their importance in other plant groups. The classification given here is of significance in as much as it plugs the gap in an otherwise a comprehensive stomatal classificatory system.

The authors are grateful to Prof. M. R. Suxena for giving facilities and encouragement.

#### Pant's classification of the mesoperigenous stomata

#### Revised classification of all the mesoperigenous stomata

		Unilabrate	Dolabrate
(i)	<i>Plagiogyra</i> type (at right angle) ..	<i>Plagiogyra</i>	Right angle type
(ii)	<i>Tetracentron</i> type (parallel to) ..	<i>Tetracentron</i>	Parallel type
(iii)	<i>Ranunculus</i> type (at any angle) ..	<i>Ranunculus</i>	At any angle

**Unilabrate Types.**—In this category are included the three mesoperigenous stomata recognised by Pant. They are designated as unilabrate as their meristemoid possesses only one cutting face giving rise to a single mesogenous subsidiary cell. Pant distinguishes these stomata from each other on the basis

1. Pant, D. D., "On the ontogeny of stomata and other homologous structures," *Plant Science Series*, 1966, 1, 1.
2. — and Banerji, R., "Structure and ontogeny of stomata in some Piperaceae," *J. Linn. Soc. (Bot.)*, 1965, 59, 223.

## LETTERS TO THE EDITOR

### STEREOCHEMISTRY OF THE CONVERSION OF ALCOHOLS TO ETHERS OVER ALUMINA

STEREOCHEMICAL studies have often proved helpful in understanding the mode of action of heterogeneous catalysts. In recent years the study of the stereochemistry of olefin formation from alcohols has thrown valuable light on the mechanism of the dehydration of alcohols over alumina.<sup>1</sup> The mechanism of ether formation over alumina has attracted much attention recently. A Rideal mechanism has been proposed for this reaction by deBoer *et al.*<sup>2</sup> while evidence in support of a Langmuir-Hinshelwood mechanism has been presented by Jain and Pillai.<sup>3</sup> In this connection it is felt that the results of a stereochemical study of ether formation that we have made will be of interest.

Mixtures of D(+)-2-butanol ( $[\alpha]^{30} = +9.4^\circ$ , 20% in methanol) and methanol were passed over a commercial alumina catalyst (Houdry Hard Alumina, Grade 200 A) at  $230^\circ$  and a contact time of 1 second. After the first passing the 2-butyl methyl ether formed along with some methanol was removed by fractional distillation and the residual 2-butanol mixed with fresh quantity of methanol and recycled. By this process a concentrated fraction consisting of 2-butyl methyl ether and methanol, uncontaminated by 2-butanol as shown by gas chromatography (carbowax-20 M, 5 ft.,  $60^\circ$ ) was obtained. After the series of recyclings the residual 2-butanol was found to have its original optical activity unaffected showing that the alcohol itself was not racemised under the experimental conditions. The 2-butyl methyl ether thus formed was laevo rotatory ( $[\alpha]^{30} = -11^\circ$ , 5% in methanol). D-2-butyl methyl ether independently prepared by the action of methyl iodide on D(+)-2-butanol sodium salt was found to be dextro rotatory. Thus the negative sign of rotation of the ether formed in the catalytic reaction shows that the reaction proceeds with inversion of configuration.

The inversion clearly indicates that the C-O bond breaking takes place mainly in 2-butanol molecule and that the methanol acts as the nucleophile in this substitution reaction. Hence it is reasonable to assume that the 2-butanol is preferentially adsorbed on acidic sites, a

conclusion which is also justified on consideration of the relative basicities of the two alcohols.

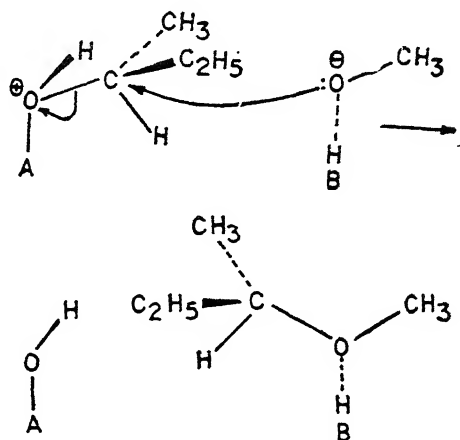


FIG. 1

The inversion of configuration shows that the adsorbed species from 2-butanol retains its original geometry and is probably an oxonium ion. Nucleophilic displacement on this species by an adsorbed methanol molecule can lead to the mixed ether with inverted configuration. This surface reaction can be represented as shown in Fig. 1. "A" represents an acidic site on the surface of alumina. The 2-butanol molecule is visualized as getting adsorbed on this acidic site through the oxygen. Such an adsorption imparts the necessary positive polarity to the C<sub>2</sub> of 2-butanol and makes it susceptible to nucleophilic attack by another alcohol molecule. The shape of this adsorbed species as visualized takes into account the pyramidal nature of trivalent oxygen. The nucleophile is visualized as a methanol molecule adsorbed on a basic site, represented as "B", through the alcoholic hydrogen.

Department of Chemistry, S. V. KANNAN.  
Indian Inst. of Tech., C. N. PILLAI.  
Madras-36, August 28, 1968.

1. Pines, H. and Pillai, C. N., *J. Am. Chem. Soc.*, 1961, **83**, 3270.
2. deBoer, J. H., Fahim, R. B., Linsen, B. G., Visseren, W. J. and deVleeschauwer, W. F. N. M., *J. Catalysis*, 1967, **7**, 163.
3. Jain, J. R. and Pillai, C. N., *Ibid.*, 1967, **9**, 322.

# STUDIES ON N-1, 1' (4, 4'-BIPHENYLENE) BIS 3-N-HYDROXY 3-N PHENYL TRIAZENE AS COMPLEXING LIGAND

THE preparation and complex forming properties of the hydroxytriazenes of the general formula  $R-N(OH)-N=N-R'$  have been evaluated by earlier workers.<sup>1-6</sup> Some of these are found to be superior to conventional analytical reagents like dimethyl glyoxime. This observation led the present authors to synthesize N-1, 1' (4, 4'-biphenylene) bis 3-N-hydroxy 3-N phenyl triazene (Fig. 1), with two  $-N(OH)-N=N-$  groups on the molecule. The method of its preparation and co-ordination behaviour is reported in this communication.

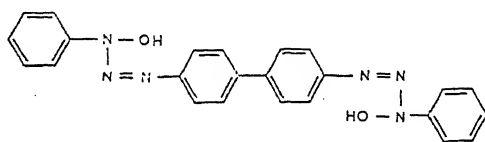


FIG. 1

Because of the geometry of this molecule and the presence of two complex forming moieties in the molecule, it is expected to form only polymeric complexes. Study of organo-metallic polymers is a problem of current interest.

The ligand is prepared by tetrazotising benzidine and coupling with phenylhydroxylamine in the presence of sodium acetate solution as a buffer. It is purified by repeated washing with water followed by alcohol to obtain it as yellow-coloured solid having m.p. 147-48°, soluble in pyridine, morpholine, dioxane, dimethylsulphoxide and dimethylformamide, sparingly soluble in alcohol, acetone, ether and benzene and insoluble in cold and hot water. The formula given for the compound is supported by microanalysis (see Table I) and I.R. spectral data.

TABLE I

Elements %	Ligand $C_{24}H_{20}N_6O_2$		Cu-complex $C_{24}H_{18}N_6O_2Cu$		Ni-complex $C_{24}H_{18}N_6O_2Ni$	
	Found	Reqd.	Found	Reqd.	Found	Reqd.
C ..	69.31	67.9	57.96	59.31	61.56	59.9
H ..	4.87	4.75	4.46	3.73	4.43	3.8
N ..	19.31	19.8	17.53	17.3	17.34	17.4
Metal ..	..	..	12.87	13.07	11.89	12.10

A solution of the ligand in dimethyl-formamide on mixing with the alcoholic solution of chlorides of Ni and Cu, and warming on a

water-bath, forms insoluble complexes having orange-red and greenish-yellow colour respectively. It only forms a deep-green colour with  $Fe^{III}$  and apparently does not react with Co, Cd, Ti, Pd and Zn under comparable conditions. The composition of the Cu and Ni complexes established by microanalysis shows the metal-ligand ratio as 1:1 (see Table I). Both of the compounds are stable above 300° C., slight darkening is noticed at 205° (Cu-complex) and 195° (Ni-complex). The extreme insolubility and high thermal stabilities of the complexes suggest their macromolecular nature which is also anticipated from the structure of the ligand.

The ligand, though appears to be more selective than 3-hydroxy 1,3-diphenyltriazene, may not be of much analytical use due to its insolubility in water which makes the studies possible only in non-aqueous media. It is found that the introduction of sulphonic acid groups in benzidine nucleus makes it much more soluble and probably more useful as a reagent.

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H. D. BHARGAWA.  
S. C. BHATTACHARYYA.

1. Bamberger, E., *Ber.*, 1896, **29**, 104; 1897, **30**, 2278; 1899, **32**, 1677; 1900, **33**, 3510.
2. Gebhard and Thompson, *J. Chem. Soc.*, 1909, **95**, 771.
3. Marjorie Elkins and Louis Hunter, *Ibid.*, 1938, p. 1346.
4. Bhattacharyya, S. C. and Sogani, N. C., *J. Ind. Chem. Soc.*, 1959, **36**, 563.
5. — and —, *Anal. Chem.*, 1958, **28**, 81, 1616.
6. Purohit, D. N., *Talanta*, 1967, **14**, 353.

## KINETICS OF THE OXIDATION OF $\alpha$ -PHENYL ETHYL ALCOHOL BY CERIC IONS

THE oxidation of a number of aliphatic alcohols—primary and secondary and also of benzyl alcohol by ceric perchlorate in perchloric acid medium—has been investigated in recent times.<sup>1,2</sup> In spite of a large amount of data in literature<sup>3</sup> on the kinetics and mechanism of this oxidation, very little work has been done on the effect of alcohol structure on the rate and mechanism of this oxidation. We have now started an investigation in this direction and present in this communication our results on the oxidation of  $\alpha$ -phenyl ethyl alcohol by ceric perchlorate in 1M perchloric



acid. The solvent system used is 50% acetic acid-water mixture and the acidity corresponds to 1M  $\text{HClO}_4$ , by a suitable addition of perchloric acid. The ionic strength has been maintained constant at 0.2M by the addition of sodium perchlorate. The reaction has been studied by following the rate of disappearance of  $\text{Ce}^{4+}$  by a titrimetric method with excess of ferrous ammonium sulphate and back titration with standard ceric ammonium sulphate employing ferroin as the indicator. The oxidation was carried out both under pseudo first order conditions (with an alcohol/ $\text{Ce}^{4+}$  ratio of 3 ~ 8) and also under second order conditions. The reaction is of clean first order in  $\text{Ce}^{4+}$  and also in the alcohol (plots A and B in Fig. 1). It can also be seen from Fig. 1

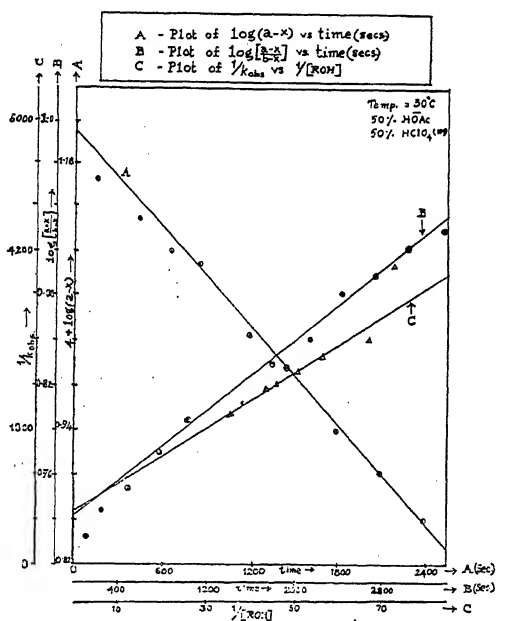


FIG. 1

(plot C) that the plot of  $1/k$  versus  $1/[\text{alcohol}]$  is linear with a definite intercept on the Y-axis. It is generally known that the oxidation of alcohols by  $\text{Ce}^{4+}$  proceeds via a previously formed cerium<sup>4+</sup>-alcohol complex<sup>1</sup> which then decomposes in a unimolecular fashion. It is thus likely that  $\alpha$ -phenyl ethyl alcohol also forms an initial complex with  $\text{Ce}^{4+}$ . It is, however, pertinent to point out here that benzyl alcohol has been reported<sup>2</sup> to be oxidised without any complex formation and this has been attributed to the -I effect

of the phenyl group preventing complex formation. We however find that  $\alpha$ -phenyl ethyl alcohol does form a complex (in spite of the phenyl on the secondary carbon atom) and is also oxidised faster than propanol-2 (Table I).

TABLE I

Solvent: 50%  $\text{HOAc-H}_2\text{O}$  in  
presence of 1M  $\text{HClO}_4$       Temperature: 30°C.  
Alcohol = 0.01002 M.       $\text{Ce}^{4+}$  = 0.001833 M.

Alcohol	$k_2 \times 10^2$ litre mole <sup>-1</sup> sec. <sup>-1</sup>
Propanol-2	1.06
$\alpha$ -Phenyl ethyl alcohol	2.08
Benzhydrol	5.72

That the effect of a phenyl group is to enhance the rate of oxidation is further shown by an additional rate increment with benzhydrol under the same conditions. This increased reactivity can be attributed to the resonance stabilisation of the immediately formed radical. Moreover the products, viz., the corresponding ketones are much more stabilised relative to the alcohol. The intermediacy of an organic radical  $\text{R}-\dot{\text{C}}(\text{OH})-\text{R}'$  by an  $\alpha$ -CH bond breaking in the rate-determining step has been demonstrated by the presence of an isotope effect ( $k_{\text{H}}/k_{\text{D}}$ ) of 1.9,<sup>5</sup> although the possibility of some attack at the oxygen-hydrogen bond has also been suggested.

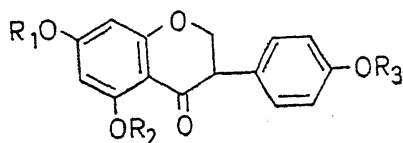
We also observe that the reaction rate is dependent on the solvent polarity. Increasing concentrations of acetic acid in the solvent mixtures increases the rate of reaction confirming the ion-dipole nature of the reaction. Increase of ionic strength also has very little effect on the rate.

Dept. of Chemistry, N. VENKATASUBRAMANIAN.  
Vivekananda College, T. R. BALASUBRAMANIAN.  
Mylapore, Madras-4,  
August 8, 1968.

1. Rangaswami, M. and Santappa, M., *Curr. Sci.*, 1965, 34, 282.
2. —, *Ibid.*, 1966, 35, 332.
3. Richardson, W. H., *Oxidation in Organic Chemistry*, Edited by Wiberg, K. B., Academic Press, New York, 1965, p. 249.
4. Ardon, M., *J. Chem. Soc.*, 1957, p. 1811.
5. Littler, J. S., *Ibid.*, 1959, p. 4135.

## SYNTHESIS OF DIHYDROPRUNETIN

WE have been interested in the synthesis of naturally occurring isoflavanones and examined a number of methods for this purpose.<sup>1,2</sup> Two approaches appeared to be promising for the synthesis of the 7-O-methyl ethers, e.g., dihydropunetin (I): (i) controlled demethylation of dihydrogenistein trimethyl ether (II) and (ii) selective methylation of the 7-hydroxyl group in dihydrogenistein (III). Dihydrogenistein trimethyl ether (II) required for this study was prepared by the catalytic hydrogenation of genistein trimethyl ether in glacial acetic acid solution using Adams' catalyst.<sup>3</sup> Good yields were obtained by restricting the time of hydrogenation to about 5 minutes; longer duration leads to further changes. Boiling (II) with acetic anhydride and hydriodic acid for 3 hours leads to complete demethylation yielding (III).<sup>4</sup> Controlled demethylation of (II) with hydriodic acid at 80° for 30 minutes gave a mixture of (I) and (III) from which the latter was removed by extraction with dilute sodium carbonate solution. By demethylating (II) with hydrogen bromide in acetic acid (30%) at 100° for 30 minutes the dimethyl ether (IV) was formed besides the monomethyl ether (I). Selective methylation of the 7-hydroxyl group in (III) to yield (I) was done by refluxing with methyl sulphate (1.2 mol.) and sodium bicarbonate in dry acetone medium for 8 hours. Dihydropunetin (I) was also prepared in poor yields by the catalytic reduction of punetin diacetate using platinum oxide catalyst followed by deacetylation; this reduction was previously carried out with palladised charcoal.<sup>5</sup>



(I)  $R_1 = \text{CH}_3$ ;  $R_2 = R_3 = \text{H}$

(II)  $R_1 = R_2 = R_3 = \text{CH}_3$

(III)  $R_1 = R_2 = R_3 = \text{H}$

(IV)  $R_1 = R_3 = \text{CH}_3$ ;  $R_2 = \text{H}$

Dihydropunetin thus prepared melted at 148° (chloroform-petroleum ether) and gave an acetate, m.p. 190° (ethyl acetate). It was homogeneous by TLC (silica gel) in (a) methanol-chloroform (2:23) and (b) benzene-

ethyl acetate (9:1). It gave a brownish-green ferric reaction and bluish-green colour with concentrated nitric acid.

[U.V. absorption ( $m\mu$ ):  $\lambda_{\text{max}}^{\text{MeOH}}$  288 (log  $\epsilon$ , 4.3);  $\lambda_{\text{max}}^{\text{MeOH-NaOAc}}$  288;  $\lambda_{\text{max}}^{\text{MeOH-AlCl}_3}$  310; I.R. spectrum (KBr,  $\text{cm}^{-1}$ ): 3500 (OH), 1667 (C=O) of an isoflavanone]. The NMR spectrum (60 MHz,  $\text{CDCl}_3$ ) of the substance was also consistent with this structure. 5-Hydroxy-7,4'-dimethoxy isoflavanone (IV) had m.p. 123-24° and 5,7,4'-trihydroxy isoflavanone (III) melted at 236°. These structures were also supported by U.V., I.R. and NMR spectra.

Padmakastein isolated<sup>6</sup> from one sample of the stem-bark of *Prunus pudum* was assigned the structure (I) on the basis of colour reactions, chemical properties and preparation of its methyl ether which agreed with synthetic dihydropunetin trimethyl ether<sup>5</sup> (II). The m.p. reported for padmakastein, however, is different from that now observed for ( $\pm$ )-dihydropunetin; the natural sample is not available for comparison and its rotation was not reported. Repeated attempts to isolate padmakastein from other samples of the bark have not so far been successful. The work is being continued.

Department of Chemistry, A. MALHOTRA.  
University of Delhi, V. V. S. MURTI.  
Delhi-7, November 7, 1968. T. R. SESHADRI.

1. Murti, V. V. S., Raman, P. V. and Seshadri, T. R., In *Symposium on the Synthesis of Heterocyclic Compounds of Physiological Interest*, Osmania University, 1964, p. 64.
2. Malhotra, A., *Ph.D. Thesis*, Delhi University, April 1968.
3. Bradbury, R. B. and White, D. E., *J. Chem. Soc.*, 1953, p. 871.
4. Inoue, N., *The Science Reports of the Tohoku University*, 1961, Series I, 45 (2), 79.
5. Ramanujam, S. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1958, 38A, 175.
6. Narasimhachari, N. and Seshadri, T. R., *Ibid.*, 1952, 35A, 202.

#### PHASE STUDIES IN THE SYSTEM: $\text{Y Nb Ti O}_6\text{-Nd Nb Ti O}_6$

THE crystal structure of Euxenite ( $\text{Y Nb Ti O}_6$ ) has been studied by a number of workers,<sup>1-3</sup> but there is no report of the phase studies in the above system. It was, therefore, selected for further studies by solid state reaction.

Samples were prepared having appropriately spaced compositions by weighing the corresponding oxides of A. R. quality and firing them at 1400° C. for twelve hours in air. After

TABLE I  
The system: Y Nb Ti O<sub>6</sub>-Nd Nb Ti O<sub>6</sub>

Composition	Colour	Phases present
1. Y <sub>0.8</sub> Nd <sub>0.2</sub> Nb Ti O <sub>6</sub>	..	Euxenite ( $a=5.564$ , $b=14.643$ , $c=5.198$ Å)
2. Y <sub>0.6</sub> Nd <sub>0.4</sub> Nb Ti O <sub>6</sub>	..	, ( $a=5.604$ , $b=14.663$ , $c=5.204$ Å)
3. Y <sub>0.4</sub> Nd <sub>0.6</sub> Nb Ti O <sub>6</sub>	..	Nd Nb Ti O <sub>6</sub> ( $a=5.913$ , $b=13.849$ , $c=8.621$ Å)
4. Y <sub>0.2</sub> Nd <sub>0.8</sub> Nb Ti O <sub>6</sub>	..	Nd Nb Ti O <sub>6</sub> ( $a=5.913$ , $b=13.849$ , $c=8.620$ Å)
5. Nd Nb Ti O <sub>6</sub>	..	Nd Nb Ti O <sub>6</sub> ( $a=5.913$ , $b=13.849$ , $c=8.621$ Å)

cooling, the samples were subjected to X-Ray powder analysis. In order to resolve low angle lines a Guinier type focussing camera was used. The results are given in Table I.

Table I shows that only limited solid solution occurs in the system. A single euxenite phase with increasing lattice dimensions is observed upto the composition Y<sub>0.6</sub> Nd<sub>0.4</sub> Nb Ti O<sub>6</sub>. The euxenite lattice can accommodate Nd<sup>3+</sup>, but only to a limited extent. On further substitution, the lattice breaks down. The structure then changes into a new orthorhombic phase of Nd Nb Ti O<sub>6</sub>.

This new compound (Nd Nb Ti O<sub>6</sub>) has not been reported in literature. It has been indexed on the basis of orthorhombic symmetry with the following lattice constants:

$$a = 5.913, b = 13.849, c = 8.621 \text{ Å}$$

There was no evidence of any other new compound in this system.

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Structural Chemistry, K. RAMA RAO.

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Nagpur (India), August 10, 1968.

1. Arnott, R. J., *Amer. Min.*, 1950, **35**, 386.
2. Alexandrov, V. B. and Pytenko, Yu. A., *Doklady Akad. Nauk. S.S.R.*, 1959, **124**, 179.
3. Deshpande, V. V., *Ph. D. Thesis*, London University, 1961.

### SOME GUANYLHYDRAZONES, THIOSEMICARBAZONES AND SEMI- CARBAZONES OF ALDEHYDES AND KETONES

ANTIBACTERIAL,<sup>1,2</sup> antiinflammatory<sup>3,4</sup> anti-fungal<sup>5</sup> and antiviral<sup>6</sup> properties have been reported for guanylhya zones of a variety of aldehydes and ketones. Antiviral activity has also been reported<sup>7-9</sup> for the thiosemicarbazones of isatin derivatives and 5-acylisothiazoles. This prompted us to prepare the guanylhya zones, thiosemicarbazones and semicarba-

zones of  $\alpha$ -formylphenylacetone nitrile,  $\alpha$ -formyl-4-chlorophenylacetone nitrile,  $\alpha$ -formyl-naphthylacetone nitrile,  $\alpha$ -acetylphenylacetone nitrile and *p*-phenylacetophenone. Of the compounds prepared (Table I), compounds No. 2 and 6 have shown activity against Ranikhet disease virus.

**$\alpha$ -Acetylphenylacetone nitrile.**—To a stirred suspension of sodium methoxide (14 g.) and phenylacetone nitrile (29 g.) in dry benzene (0.5 l.) was added ethylacetate (24 g.) at 35° over 10 minutes. The reaction mixture was warmed to 60°, and then stirred at 45° for 1 hour. The reaction mixture was cooled to 10° and then treated with sodium hydroxide solution (2%; 300 ml.) and the aqueous phase was separated, clarified with activated carbon and then acidified with hydrochloric acid to congo red. The solid thus obtained was crystallized from benzene-hexane; m.p. 85–86°. Found: N, 8.83; Calc. for C<sub>10</sub>H<sub>9</sub>NO: N, 8.80%.

**$\alpha$ -Formyl-(1-naphthyl)-acetone nitrile.**—This was prepared following the procedure described for  $\alpha$ -acetylphenylacetone nitrile. The product melted at 130–31°. Found: N, 7.05; Calc. for C<sub>13</sub>H<sub>9</sub>NO: N, 7.18%.

**Guanylhya zone sulphate of  $\alpha$ -Acetylphenylacetone nitrile.**— $\alpha$ -Acetylphenylacetone nitrile (2 g.) and guanylhya zone sulphate (2.4 g.) were refluxed for two hours in aqueous ethanol (1:3; 30 ml.). The reaction mixture was filtered hot and allowed to cool; the solid obtained was crystallized from aqueous ethanol; m.p. 183–85° (d). Found: N, 24.40; Calc. for (C<sub>11</sub>H<sub>13</sub>N<sub>5</sub>)<sub>2</sub> · H<sub>2</sub>SO<sub>4</sub> · 2H<sub>2</sub>O: N, 24.82%.

**Thiosemicarbazone of  $\alpha$ -formyl-(1-naphthyl)-acetone nitrile.**—Thiosemicarbazide (2 g.) and  $\alpha$ -formyl-(1-naphthyl)-acetone nitrile (2 g.) were refluxed for 1 hour in aqueous methanol (50%; 40 ml.) containing acetic acid (2 ml.), filtered hot and cooled. The solid obtained was crystallized from dilute acetic acid; m.p. 153–55°. Found: N, 21.30; Calc. for C<sub>14</sub>H<sub>12</sub>N<sub>4</sub>S: N, 20.89%.

TABLE I

No.	Compound	Mol. formula	*m.p. °C.	Nitrogen %	
				Found	Calcd.
Guanyl hydrazone of					
1	A hydrochloride	.. $C_{10}H_{11}N_5 : HCl : 2H_2O$	170-72 ( <i>d</i> )	25.55	25.60
2	A sulphate	.. $(C_{10}H_{11}N_5)_2H_2SO_4 : 2H_2O^\dagger$	198-200 ( <i>d</i> )	26.50	26.11
3	B	.. $C_{10}H_{10}N_5Cl$	134-36	30.10	29.73
4	B sulphate	.. $(C_{10}H_{10}N_5Cl)_2H_2SO_4$	202-05 ( <i>d</i> )	25.00	24.60
5	C hydrochloride	.. $C_{15}H_{16}N_4 : HCl$	269-70	20.01	19.41
6	C sulphate	.. $(C_{15}H_{16}N_4)_2H_2SO_4$	260-62 ( <i>d</i> )	18.21	18.61
7	D sulphate	.. $(C_{14}H_{13}N_5)_2H_2SO_4 \cdot 2H_2O$	205 ( <i>d</i> )	22.29	22.01
8	E sulphate	.. $(C_{11}H_{13}N_5)_2H_2SO_4 : 2H_2O$	183-85 ( <i>d</i> )	24.40	24.82
Thiosemicarbazone of					
9	B	.. $C_{10}H_9N_4ClS$	142-43	21.90	22.18
10	D	.. $C_{14}H_{12}N_4S$	153-55	21.30	20.89
Semicarbazone of					
11	A	.. $C_{10}H_{10}N_4O$	176-78 ( <i>d</i> )	27.46	27.72
12	B	.. $C_{10}H_9N_4ClO$	174-76	23.81	23.68
13	D	.. $C_{14}H_{12}N_4O$	172-73	21.87	22.22

A =  $\alpha$ -Formylphenylacetoneitrile; B =  $\alpha$ -Formyl 4-chlorophenyl-acetonitrile; C = 4-Phenylacetophenone;

D =  $\alpha$ -Formyl-1-naphthyl-acetonitrile; E =  $\alpha$ -Acetylphenylacetoneitrile.

\* All melting-points are uncorrected.

† Sulphur % found was 5.98 as against 5.97 calculated.

**Semicarbazone of  $\alpha$ -formyl-(4-chlorophenyl)-acetoneitrile.**—Semicarbazide (1.5 g.) and  $\alpha$ -formyl-(4-chlorophenyl)-acetoneitrile (2.2 g.) were refluxed in aqueous ethanol (50%; 40 ml.) containing acetic acid (1 ml.) for 30 minutes. The solid obtained on cooling was crystallized from ethanol; m.p. 174-76°. Found: N, 23.81; Calc. for  $C_{10}H_9N_4ClO$ : N, 23.68%.

The remaining compounds were prepared according to the above examples.

Sarabhai Research Centre, S. SOMASEKHARA.  
Wadi Wadi, V. S. DIGHE.  
Baroda, August 20, 1968. S. L. MUKHERJEE.

1. *Brit. Pat.*, 763,089; Farbenfabriken Bayer, A. G., C.A., 1957, 51, 16539.
2. *Austrian Pat.*, 190,941; Österreichische Stickstoff Werke, A.G.; *Ibid.*, 1957, 51, 16542.
3. *Fr. Pat.*, 1745 M; *Fine Chem. Pat. J.*, 1963, 3 (20), 3.
4. *Brit. Pat.*, 894,809; *Ibid.*, 1962, 2 (20), 2.
5. *Brit. Pat.*, 932,951; C.A., 1964, 60, 1607.
6. Freedlander, B. L. and French, F. A., *Cancer Research*, 1958, 18, 300.
7. Bauer, D. J. and Sadler, P. W., *Brit. J. Pharmacol.*, 1960, 15 (1), 101; C.A., 1960, 54, 18777.
8. Varma, R. S. and Nobles, W. L., *J. Med. Chem.*, 1967, 10, 510.
9. *Brit. Pat.*, 997,375; *Fine Chem. Pat. J.*, 1965, 5 (31), 2.

## CROSSABILITY OF COMMON WHEAT VARIETIES WITH RYE

DIFFERENCES are known to exist among varieties of common wheat in their crossability with rye. For example, the variety Chinese Spring crosses readily with rye while the European varieties of common wheat show poor crossability. In the present study, hexaploid wheat varieties from different countries were tested for the readiness with which they cross with rye (variety Prolific early) in order to find out: (a) whether any significant differences in crossability exist among them, and (b) whether any of the Indian bread wheat varieties show easy crossability with rye.

The various wheat varieties used in crosses and the percentage of seed set are given in Table I. As expected, Chinese Spring was the most readily crossable with a seed set of 65.2%. While most of the remaining varieties showed 0 to 2.15% seed set, one of the Indian wheat varieties, Pb-C-281 showed 4.43% seed set and the other Indian wheat variety, Niphad-4, showed 18.92% seed setting.

Lein<sup>1</sup> studied segregation for crossability among the  $F_2$  progeny of a cross between readily crossable and poorly crossable varieties. He found that differences in crossability involved two pairs of alleles and suggested that

TABLE I

Percentage of seed set in crosses between different bread wheat varieties and rye

Cross	No. of florets pollinated	% of seed set
Axminster × Rye	.. 214	1.40
Kenya × Rye	.. 178	0.56
White Federation—38 × Rye	.. 182	..
Red Egyptian × Rye	.. 249	1.61
Chinese Spring × Rye	.. 316	65.20
Hope × Rye	.. 132	0.76
Timstein × Rye	.. 140	2.15
Israeli var. × Rye	.. 132	1.52
Florenze Aurore × Rye	.. 128	0.78
Indian var. Pb C.281 × Rye	.. 158	4.43
Indian var. NI-4 × Rye	.. 148	18.92

the readily crossable variety Chinese-466 carried  $Kr_1Kr_1Kr_2Kr_2$  and the poorly crossable varieties Marquis and Peragis carried  $Kr_1Kr_1Kr_2Kr_2$ . An intermediate level of crossability was shown by the variety Blausamtiger Kolben and he designated it  $Kr_1Kr_1Kr_2Kr_2$  and concluded that  $Kr_1$  reduced crossability to a greater extent than  $Kr_2$ .

Riley and Chapman<sup>2</sup> crossed rye with lines in which individual chromosomes of the poorly crossable variety Hope were substituted for the homologous Chinese Spring chromosomes. While Chinese Spring showed 74.3% crossability, Chinese Spring with chromosome 5B pair of Hope showed only 6.4% fertile florets and the line with chromosome 5A of Hope showed 26.2% seed set in crosses with rye. They concluded that chromosome 5B carries  $Kr_1$  and chromosome 5A carries  $Kr_2$ . Since in the variety, Niphad-4, 18.92% of the pollinated florets set seed, it probably carries only  $Kr_2$  in which case its genotype would be  $Kr_1Kr_1Kr_2Kr_2$ . The other Indian wheat variety, Pb-C-281, shows only 4.43% crossability with rye thereby indicating that it probably carries the more efficient inhibitor of crossability,  $Kr_1$ . These findings might be of interest to Indian wheat workers in the production of *Triticale*, the wheat-rye hybrid.

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## A LIVING FOSSIL PLANT COMMUNITY IN SOUTH INDIAN HILLS

CLOSED evergreen forest, called the Shola, occurs above 1700 m. in patches in the higher hills of South India in the Nilgiris, Annamalai and Palni Hills. The forest is short-boled and attains a low height of about 16 to 20 m. Inhabiting montane situation, the patches of forest are under the impact of equable climate with a well distributed rainfall from both the monsoons, which varies from 150 mm. to 650 mm. or even more. The reddish or yellow clay is covered in the forested region by varying depth of humus-rich black soil. Besides the effect of high speed winds clearly seen in the form of the trees and the windward edge of the community, the effects of fire and grazing are very pronounced especially during the months of February to March. The Todas, the nomadic graziers, are the earliest known inhabitants of the Nilgiris, whereas the farming tribes reached the Nilgiris much later.<sup>1</sup>

The effect of burning and clearance has adversely affected the Sholas with the result that they occur today in patches in hollows or sheltered folds in the hills surrounded by the rolling downs. The rich soil exposed after the clearance of the forest erodes rapidly under the prevalent climatic conditions and the operating biotic factor resulting in the absence of suitable edaphic conditions for the regeneration of the forest. The recent phytosociological study made by us in connection with pollen analytical investigations has revealed that the fast receding Shola community is a dying community in which regeneration has altogether stopped. The presence of stray trees of *Rhododendron nilgircum* with patches of *Gaultheria* in open grass lands suggests either a pioneer seral stage in the xerarch succession or more certainly the remnants of disforestation. Any evidence of xerarch succession leading to the formation of Shola forest is lacking.

The Shola forest community has been widespread in the past<sup>2</sup> and this fact has been established through distinct distribution of the community in sheltered folds in the mountains and recent pollen analytical investigations carried out by us<sup>3,4</sup> at Ootacamund in the Nilgiris. The progressive recession of the community has obviously been due to both the climate and the biotic factor which have not only reduced the community in its extent but have created conditions under which the community has stopped regeneration.

1. Lein, A., *Z. Indukt. Abstamm. u. Vererb. Lehre*, 1943, 81, 28.
2. Riley, R. and Chapman, V. *Genet. Res., Camb.*, 1967, 9, 259.

The above facts tend to suggest that the non-regenerating and fast receding Shola forest is almost a dying community and deserves to be more appropriately called a living fossil community. It will not be a wonder if in course of time the community virtually goes out of existence. If that is so then the Shola forest in the Nilgiris and the adjoining hills in the South of India is an interesting case of a living fossil community.

Birbal Sahni Inst. of  
Palaeobotany,  
Lucknow, August 30, 1968.

VISHNU-MITTRE.  
H. P. GUPTA.

1. Grigg, H. B., *A Manual of Nilgiri District, Madras*, 1880.
2. Champion, H. G., *Indian For. Rec. (N.S.)*, 1936, 1.
3. Vishnu-Mittre, *Abstract Proc. Palaeobot. Soc. Special Session, Lucknow*.
4. Gupta, H. P., *Ph.D. Thesis*, Univ. Lucknow, 1966.

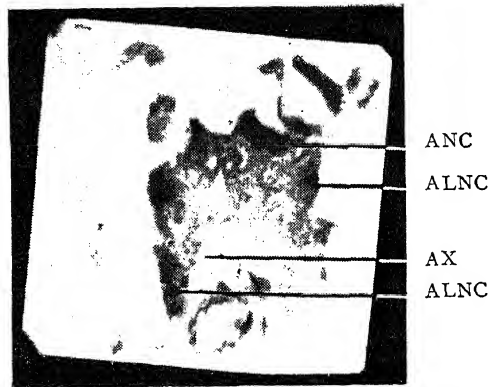
#### NEUROSECRETION AND NEUROSECRETORY CELLS IN A CALANOID COPEPOD, *HELEODIAPTOMUS* SP.

THE numerous reports on the endocrinology of crustaceans are based on the findings on "Malacostraca" only and the "Entomastrea" has been completely neglected.<sup>1</sup> Save for a note on the neurosecretion in *Calanus finmarchicus*,<sup>2</sup> no investigation has been attempted on copepods. Therefore, *Heleodiantomus* sp., a common calanoid found in the temporary pools and ponds at Madurai, was studied.

The neurosecretory cells are distinct and always found as discrete groups in the brain. Two such groups occur as a pair each on the antero-lateral sides and at the anteriormost part of the brain (Fig. 1). The cells range from 1-2  $\mu$  in diameter. They contain strongly stained basophilic neurosecretory granules and in many of the cells, the nucleus is not traceable. Whenever the nucleus is seen, the nucleolus is very prominent, whereas the nucleus does not exhibit any affinity towards the stains. Vacuoles are also present along with the neurosecretory granules. A careful examination of the cells revealed that they are obviously involved in the cyclic secretory activity.

The fibrous axons of the anteriormost group of neurosecretory cells extend in two distinct and separate bundles towards the anterior side. They run parallel for a short distance, but finally unite underneath the frontal organ (Fig. 2). At the same time, some of the neurosecretory fibrous axons are also found to run

along the lateral margin of the brain and enter into the lateral group of neurosecretory cells (Fig. 1). The axons of these neurosecretory cells extend up to the middle of the brain and end near a blood sinus (Fig. 1). However, these axons are not as distinct as the axons of the anterior group of cells.



FIGS. 1-2. Fig. 1. Photomicrograph to show the neurosecretory cell centres in the anteriormost part of the brain (ANC), antero-lateral part of the brain (ALNC) and their axonal pathways (AX),  $\times 800$  L.S. Fig. 2. Photomicrograph to show the axonal pathway of anterior neurosecretory cells (AX),  $\times 900$  L.S.

Since the neurosecretory cells and their extensive axons are always found intricately associated with the nerve cells, it may be possible that the secretory activity of the neurosecretory cells are regulated by the nerve impulses.

It is of interest to note that in *Calanus finmarchicus*, which is also a calanoid copepod, two distinct neurosecretory cell groups are found at the antero-lateral sides of the brain, the axons of which are found passing towards the frontal organ.<sup>2</sup> It

has been suggested that the neurosecretory cells of *Calanus finmarchicus* may control diapause and moulting. Some chromactivating substances were also identified in the extracts of the brain of *Calanus finmarchicus* and *Euchaeta norvegica*.<sup>2</sup>

Since *Heleodiptomus* sp., collected at Madurai, does not appear to undergo any diapause in its life-history, the endocrine secretions from the neurosecretory cells may regulate moulting and metabolic functions associated with it.

I am grateful to Prof. S. Krishnaswamy for suggesting the problem and guidance.

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August 30, 1968.

1. Carlisle, D. B. and Knowles, F. G. W., *Endocrine Control in Crustaceans*, Cambridge University Press, 1959.
2. — and Pitman, W. J., *Nature*, 1961, 190, 827.

#### IDENTITY OF TOMATO BIG BUD VIRUS AND EGG PLANT LITTLE LEAF VIRUS

CRANBERRY false-blossom disease in the U.S.A., tomato big bud disease in Australia, tomato stolbur or fruitwoodiness disease in the U.S.S.R. and egg plant little leaf disease in India are known to exhibit more or less similar symptoms. The symptoms common to these diseases are phyllody and virescence of floral parts, proliferation of axillary buds and smalling of leaves. The close similarity and possible identity of these viruses have been commented upon.<sup>1,3</sup> These viruses are considered to be synonymous with one another.<sup>5</sup>

Thomas and Krishnaswamy<sup>4</sup> successfully infected tomato with the egg plant virus through grafting. Though characteristic little leafing and sprouting of axillary buds were observed, they did not comment on the similarity of brinjal little leaf virus and the tomato big bud virus. Indeed, they considered the egg plant virus to be new and different from the then known viruses.

In a comprehensive study of the little leaf disease of egg plant, the virus was transmitted very easily to tomato by side wedge grafting. Symptoms were observed 15 to 20 days after grafting. The typical symptoms of big bud of tomato, i.e., enlargement of the whole calyx

to form a bladder-like structure with a toothed opening at the tip (known as big bud) (Fig. 1)

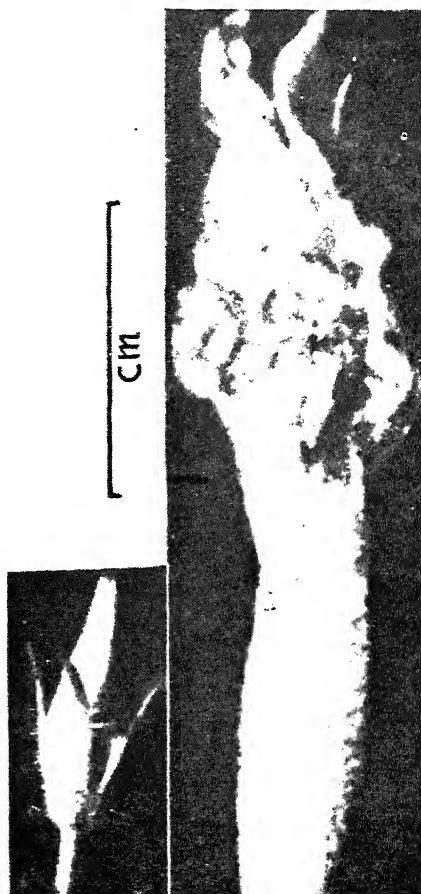


FIG. 1. L: Flower-bud from healthy tomato plant. R: Flower bud from egg plant little leaf virus inoculated tomato plant.

upright position of flower trusses; phyllody and virescence of floral parts; proliferation of axillary buds resulting in a rosette appearance of the infected plant; smalling of leaves; thickening of stem, pedicel and peduncle; occurrence of dichotomously branched shoots terminating in papillae which are purple in colour and development of purple pigment on the youngest portions of stems, veins of the bladder-like calyces and undersides of the young leaves<sup>4</sup> were observed in the experimentally infected tomato plants of varieties H. 204 and Marglobe. Thickening and elongation of pedicel were very distinct (Fig. 1) and were observed in many infected flowers. Anatomical observation at these portions

revealed an abnormal and excessive multiplication of the inner phloem mainly consisting of companion cells with distinct nuclei. Different flower modifications described in the infected plants<sup>1</sup> were observed not only in tomato but also in egg plant. Many host plants susceptible to tomato big bud virus in the family Solanaceae were readily infected by the present virus. *Lycopersicon esculentum* Mill., *L. pimpinellifolium* Mill., *Nicotiana tabacum* L., *N. rustica* L., *N. glutinosa* L., *N. glauca* R. Grah., *Solanum melongena* L., *S. tuberosum* L., *S. nigrum* L., *S. dulcamara* L., *Capsicum annuum* L., *Datura stramonium* L., *D. fastuosa* L., *D. metel* L., *D. ferox* L., *Nicandra physaloides* Gaertn., *Vinca rosea* L., *Cosmos bipinnatus* Cav. and *Argemone mexicana* L. were some of the susceptible host plants for both viruses. Of these, natural occurrence of little leaf virus was noticed on *Datura fastuosa*, *D. metel*, *Vinca rosea* and *Argemone mexicana*. *Datura fastuosa* and *Argemone mexicana* were also natural host plants to tomato big bud virus.<sup>2</sup>

The results presented seem to confirm that the egg plant little leaf virus is identical with the tomato big bud virus of Australia which has again been considered to be the same as the tomato 'stolbur' virus of U.S.S.R. and the Cranberry false blossom virus of the U.S.A.

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1. Hill, A. V., "Host range and distribution of tomato big bud," *J. Aust. Inst. Agric. Sci.*, 1940, 6, 159.
2. —, "Insect transmission and host plants of virescence (Big bud of tomato)," *J. Conn. Sci. Industr. Res., Australia*, 1943, 16, 86.
3. Kunkel, L. O., "Studies on cranberry false blossom," *Phytopathology*, 1945, 35, 805.
4. Samuel, G., Bald, J. G. and Eardley, C. M., "Big bud' a virus disease of the tomato," *Ibid.*, 1933, 23, 641.
5. Smith, K. M., *Text-Book of Plant Virus Diseases*, J. & A. Churchill, London, 1957, p. 652.
6. Thomas, K. M. and Krishnaswamy, C. S., "Little leaf—A transmissible disease of Brinjal," *Proc. Ind. Acad. Sci.*, 1939, 10 B, 201.

#### MELANOPHORES IN BLOOD VESSEL WALLS OF *RANA TIGRINA*, DAUD.

Blood vessel walls of *Rana tigrina* were studied for some histochemical investigations. During the studies, it was observed that blood vessels from all regions of the body show a large number of melanophores in their walls. Morphological studies showed that in freshly sacri-

ficed frogs, they are mainly of reticulostellate type (Fig. 1, A). On an average, their size ranges from 70 to 163 microns in length and from 41 to 61.2 microns in breadth. Their density of distribution is higher in arteries than in veins (Table I). Histological studies revealed that they lie in adventitia (Fig. 1, B).

TABLE I  
Size and density of distribution of melanophores in blood vessels

Name of blood vessel	Size in microns		Density/square mm.
	Length	Breadth	
Pre-cava	.. 70.00	61.20	22.00
Sinus venosus	.. 149.70	57.20	22.00
Post-cava	.. 150.00	46.00	24.00
Pelvic and femoral	.. 102.00	41.00	27.00
Systemic arch	.. 153.00	54.20	38.00
Coeliaco mesentric	.. 163.00	44.20	40.00
Dorsal aorta	.. 122.40	41.00	40.00
Iliac and sciatic	.. 140.50	43.00	38.00

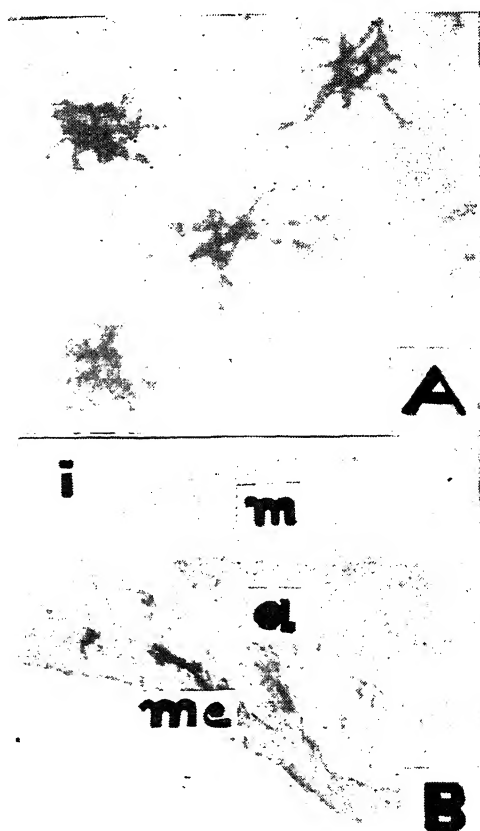


FIG. 1 (A-B). A. Reticulostellate type of melanophores from wall of pelvic vein,  $\times 700$ . B. T.S. of Coeliaco mesentric artery. i, intima; m, media; a, adventitia; me, melanophore,  $\times 320$ .



An attempt was made to study such or other types of chromatophores in blood vessel walls of Pigeon-Columba and Lizard-Calotes but, without success. There is no record to state that they are found in blood vessel walls of human beings.

Hence, this interesting observation has been presented here.

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### ON THE DIVERSE ABERRATION- MUTATION RATIO INDUCED BY NMU

A SERIES of nitroso-containing chemicals and 1,4-bis diacetyl butane have been termed as "supermutagens" by Rapoport,<sup>1</sup> as they are known to have induced more than 100% sex-linked mutations in *Drosophila*.<sup>2</sup> Our previous investigations<sup>3</sup> have demonstrated that N-nitrosomethyl urea (NMU) is capable of inducing from 20 to 70 times more changes than gamma-rays and fast neutrons, which can be recorded in  $M_1$  itself. Some of these mutagens are reported to have induced chromosomal aberrations in about 60% mitotic cells of wheat,<sup>4</sup> while others reduce even the spontaneous rate of gross chromosomal changes.<sup>5</sup>

The cytological effect of NMU was compared with gamma-rays and fast neutrons in garden pea (variety Krupnoplodny G-20) using a series of doses known for their relative mutagenic efficacy (Table I).

with the following rates: EI-4.5% mutants and 33.9% mutations per  $M_2$  plant progeny; DES-9.8% mutants and 74.3% mutations. Thus NMU was the most efficient out of all the mutagens studied here, and it was about 6-8 times more effective than the two irradiations. The frequency of chromosomal aberrations, on the contrary, was the lowest with NMU (15.5%), which was about half of the gamma-ray treatment (31.9%). Fast neutrons caused cytological damage to 27.7% cells at first mitosis. It was also observed that a higher proportion of dicentric bridges was recorded after gamma-irradiation, while the relative frequency of acentric fragments was higher following treatment with fast neutrons and NMU, which suggests that the latter agents somehow inhibit the joining of broken ends of the chromosomes.

A relatively low percentage of chromosomal aberrations accompanied by manifold increase in mutation frequency induced by NMU provides an opportunity to conclude that high mutation rate obtained after treatment with supermutagens is not related with chromosomal aberrations. Similar results were obtained by Corwin<sup>6</sup> with NMU in *Drosophila*, Heiner *et al.*<sup>7</sup> with DES and Natarajan and Ramanna<sup>8</sup> with ethyl methanesulphonate in barley, but as demonstrated by Rapoport and Zoz<sup>9</sup> this phenomenon is more pronounced with the more efficient mutagens. These mutagens, particularly chemical agents, give rise to a multiplicity of minute chromosomal rearrangements and point mutations which cannot be

TABLE I

Mutation frequency and chromosomal aberrations induced by gamma-rays, fast neutrons and NMU

Mutagen	Dose	Mutation frequency		Chromosomal aberrations				Ratio Frag- ments : Brid- ges
		% mutants	% mutations per plant progeny	No. of cells analysed	% cells with fragments	% cells with bridges	% total aberra- tions	
Control	.. ..	0.77	..	881	0.29	0.25	0.54	1 : 0.86
Gamma-rays	.. 2-4 kr	2.6	13.2	2498	10.2	21.7	31.9	1 : 2.12
Fast neutrons	.. 100, 200 rads	2.4	16.7	975	15.5	12.2	27.7	1 : 0.79
NMU	.. conc. : 0.0015 to 0.0125%; duration : 1 to 4 hrs.	22.2	87.5	1925	9.0	6.5	15.5	1 : 0.72

In the experiments carried out to compare mutation frequency two more chemicals were included-ethylene imine (EI) and diethyl sulphate (DES), which induced mutations

observed under a light microscope. Substances like NMU have been demonstrated to induce high sterility of plants in  $M_1$  generation,<sup>9</sup> which also can be correlated with high

frequency of non-lethal chromosomal changes and simultaneous accumulation of several mutations in a genome.

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1. Rapoport, I. A., *Supermutagens*, Nauka, Moscow, 1966, p. 9.
2. —, *Doklady Acad. Sci. USSR*, 1963, 148, 696.
3. Sharma, B. and Rapoport, I. A., *Mechanism of Mutation and Inducing Factors*, Academia, Prague, 1966, p. 335.
4. Makarova, S. I., *Supermutagens*, Nauka, Moscow, 1966, p. 116.
5. Rapoport, I. A. and Zoz, N. N., *Cytologia*, 1962, 4, 330.
6. Corwin, H. O., *Mutation Res.*, 1968, 5, 259.
7. Heiner, R. E., Konzak, C. F., Nilan, K. A. and Legault, R. R., *Proc. Nat. Acad. Sci. USA*, 1960, 48, 1215.
8. Natarajan, A. T. and Ramanna, M. S., *Mechanism of Mutation and Inducing Factors*, Academia, Prague, 1966, p. 367.
9. Sharma, B., *Supermutagens*, Nauka, Moscow, 1966, p. 143.

# INTERSPECIFIC HYBRIDS OF *COFFEA CANEPHORA* AND *C. ARABICA*

SPONTANEOUS AND ARTIFICIAL interspecific hybrids between diploids and diploid and tetraploid species of *Coffea* have been reported from Brazil, Belgian Congo and Indonesia.<sup>2-6,8-9,12</sup> Hybrids from *C. arabica* and *C. canephora* were obtained mainly with the purpose of obtaining plants superior to the existing ones. Backcrosses with *C. arabica* have been reported to have slightly raised the fertility. Fertile, 66 chromosome *Arabica-Canephora* amphidiploids obtained by colchicine treatment have also been reported by Brazilian workers.<sup>6,8</sup>

In India interspecific hybridization was initiated from 1930 at Central Coffee Research Institute. Frequently planters on their own initiative have indulged in trials with generation of naturally occurring *Arabica-Canephora* hybrids. Preliminary studies on crosses involving *C. arabica* ( $2n=44$ ), *C. canephora* ( $2n=22$ ), *C. congensis* ( $2n=22$ ), *C. liberica* ( $2n=22$ ), *C. excelsa* ( $2n=22$ ) and *C. eugenioides* ( $2n=22$ ) have been recorded.<sup>1,7,10,11</sup> *C. canephora* × *C. arabica* has been pursued with considerable attention with backcrossing and selfing programme in view to obtain planting material having vigour, hardiness, greater resistance to leaf rust and good quality beans.

*C. canephora* selection 274 1/11 was crossed with *C. arabica* var. *kents*—450 2/1 in 1937

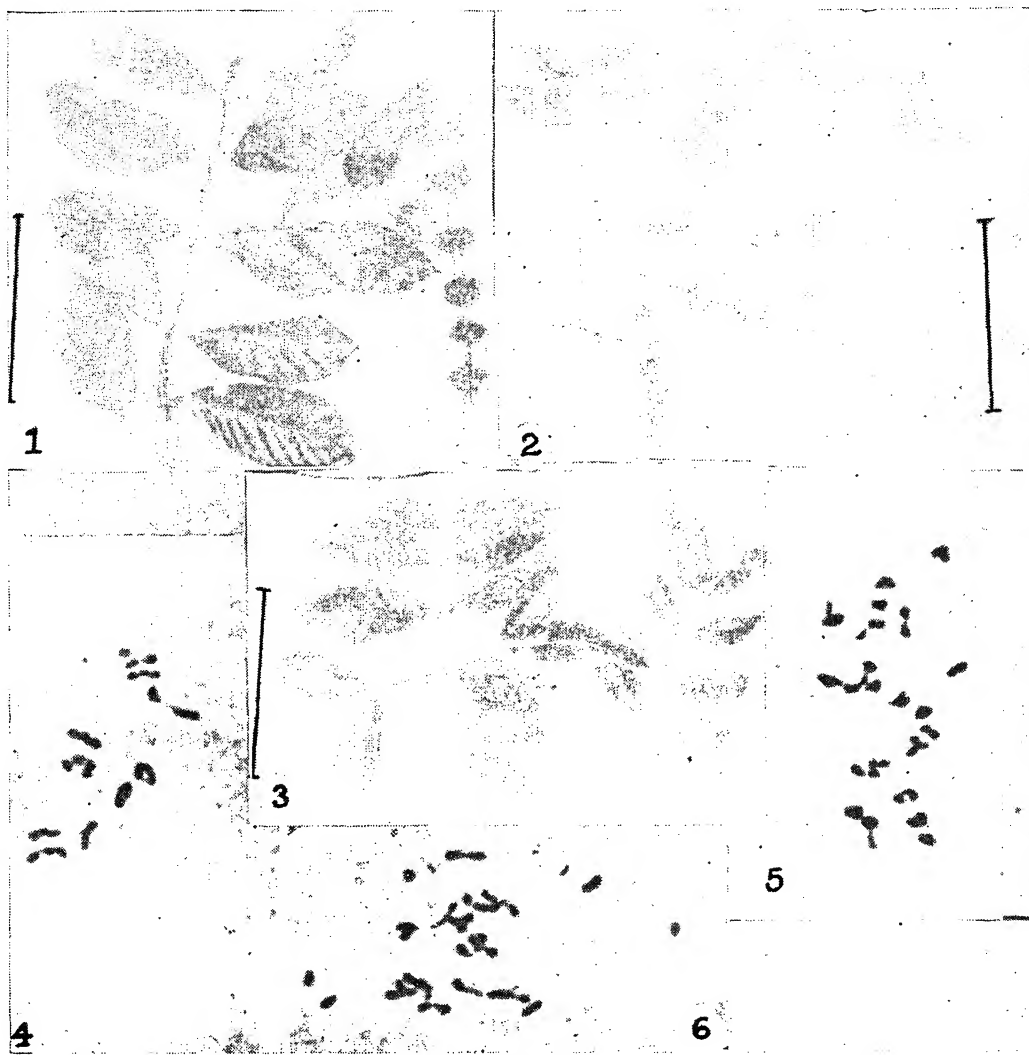
(Figs. 1, 2). 794 seeds were obtained of which 11 seeds germinated. From these six plants were raised and planted in the field. One triploid hybrid ( $2n=33$ ) was selected for studies. Pollen from both the parents was used on the triploid to obtain backcross progeny in 1942. Backcross with *C. canephora* gave 44 seeds of which 25 germinated. Out of these four plants are surviving. All the four plants are tetraploids ( $2n=44$ ). From backcross with *C. arabica* 63 seeds were obtained; of these 59 germinated and 48 seedlings raised were planted in the field. Of these 23 plants at random chosen for chromosome number showed tetraploidy.

Detailed cytology of the parents and the  $F_1$  hybrid was studied. Meiosis in the parent plants was regular. *C. canephora* at metaphase I showed 0-2 I, 10-11 II with mean per cell being 0.07 I and 10.93 II (Fig. 4). *C. arabica* at MI showed 0-6 I, 17-22 II, 0-2 III and 0-1 IV with mean per cell I 0.67, II 20.93, III 0.40 and IV 0.07 (Fig. 5).

The triploid hybrid is vigorous and is almost intermediate between the two parents (Fig. 3). Profuse flowering is noticed every year but fruit set is very poor. High percentage of 'Pea berry', 80% and above, is noticed. Selfing was a failure so far. Meiosis was irregular. At metaphase I 3-11 I, 7-12 II, 1-3 III, 0-1 IV and 0-1 V were observed. Mean association from 46 cells was I 7.98, II 9.55, III 1.93, IV 0.02 and V 0.02 (Fig. 6). Successive stages of meiosis was highly irregular. Pollen-grains were polymorphic in nature and 55.1% of them were stained.

In a triploid hybrid obtained from a cross between *C. arabica* var. *typica* and *C. canephora* Krug and Mendes (4,12) have recorded the mean association at metaphase I to be 14.4 I, 5.4 II and 2.6 III. In the present studies on the triploid hybrid mean association was 7.98 I, 9.55 II, 1.93 III, 0.02 IV, 0.02 V. It thus appears that there may be more homology between the genomes of *C. arabica* var. *kents* and *C. canephora* than between *C. arabica* var. *typica* and *C. canephora* used by the Brazilian workers.

In either of the backcrosses tetraploid plants are frequent. It could be assumed that this may be due to gametes with 22 and 33 chromosomes are viable in the triploid hybrid and are fertilized by *C. arabica* and *C. canephora* pollen respectively or backcross hybrid embryos with 44 chromosomes had more survival value.



FIGS. 1-6. Fig. 1. *C. canephora*. Fig. 2. *C. arabica*. Fig. 3. Triploid  $F_1$  hybrid. Fig. 4. *C. canephora* metaphase I showing 11 bivalents. Fig. 5. *C. arabica*, early metaphase I with 22 bivalents. Fig. 6. Triploid at MI showing V 1, IV 1, III 2, II 6, I 6.

The four plants from backcross with *C. canephora* seem to be highly abnormal and undesirable. While some of the plants from the backcross with *C. arabica* are showing high amount of fertility and other desirable characters and hence are promising for further selection.

I am grateful to Mr. R. L. Narasimhaswamy, Director of Research and Mr. S. Vishweshwara, Head of Division of Botany, for the guidance and encouragement.

Division of Botany, C. C. CHINNAPPA.  
Central Coffee Res. Institute,  
Chikmagalur District, Mysore, August 5, 1968.

1. *Annual Reports, Coffee Board, Research Dept.*, 1955-58, Nos. 9, 10, 11.
2. Cramer, P. J. S., *SIC Editorial*, IICA, Turrialba, Costa Rica, 1957.
3. Ferwerda, F. P., *Adv. in Coffee Pro. Tech.*, *Coffee & Tea Industries*, 1958, 81, 58.
4. Krug, C. A. and Mendes, A. J. T., *Jour. Gen.*, 1940, 39, 189.
5. — and —, *Bragantia*, 1941, 1, 467.
6. — and Carvalho, A., *Ibid.*, 1952, 12, 141.
7. Mayne, W. W., *Indian Coffee Board*, Bangalore, 1946.
8. Mendes, A. J. T., *Bragantia*, 1947, 7, 221.
9. Medina, D. M., *Ibid.*, 1963, 22, 229.
10. Narasimhaswamy, R. L., *Indian Coffee Board Month. Bull.*, 1950, 14, 83.
11. — and Vishweshwara, S., *Indian Coffee*, 1961, 25, 104.
12. Sybenga, J., *Genetics and Cytology of Coffee—A Literature Review*, The Hague Martinus Nijhoff, 1961.

# ONTOGENY, STRUCTURE AND DISTRIBUTION OF TRICHOMES ON THE FLORAL PARTS OF *ALECTRA THOMSONI*

VARIOUS types of epidermal appendages occur on different organs of plants. From time to time, several workers have studied their development in numerous taxa such as the members of the Compositæ (Carlquist,<sup>1-3</sup> Ramayya<sup>4</sup>), Labiatae (Mathur<sup>5</sup>) and Lentibulariaceae (Farooq and Siddiqui<sup>6</sup>). The Scrophulariaceae show many non-glandular (simple and branched) and variously-shaped glands (Metcalf and Chalk<sup>6</sup>).

appendages on the floral parts of *Alectra thomsoni* Hook. (Scrophulariaceae). The material was collected from Pachmarhi (Madhya Pradesh) and fixed in FAA. After usual processing, sections were cut at 6-10  $\mu$  and stained with safranin-fast green.

An epidermal cell functions as the hair initial and divides periclinally (Fig. 1, A, B). Further development is confined to the terminal cell (Fig. 1, C), whereas the lower one forms the basal cell. The divisions in the terminal cell are irregular giving rise to different types of glandular and non-glandular trichomes.

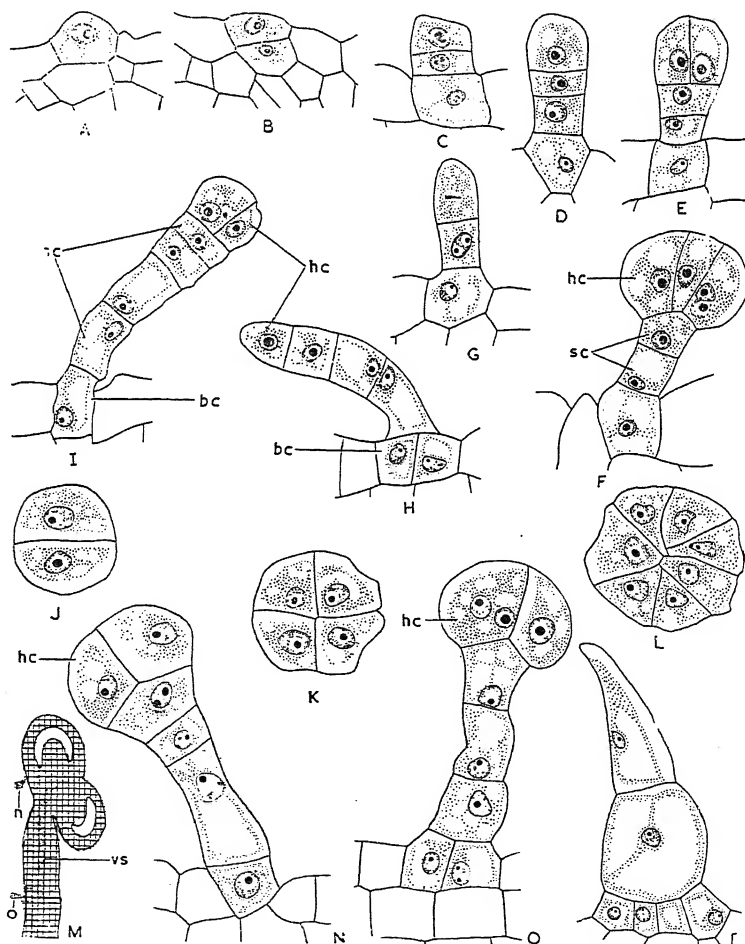


FIG. 1. A-P. Ontogeny of trichomes. A. Epidermal hair initial. B-D. 2, 3 and 4-celled stages. E, F. Capitulate hairs. G-I. Stages leading to the development of long-stalked hairs. J-L. Transections through heads of glandular hairs. M. Longisection of stamen (diagrammatic) to show the position of glandular hairs. N, O. Enlargement of portions marked z and o in M. P. Uniseriate hair with 4 basal cells. Fig. 1. A-L, N-P,  $\times 950$ ; M,  $\times 210$ . (bc, basal cell; hc, head cell; sc, stalk cell; vs, vascular supply.)

This communication deals with the ontogeny, structure and distribution of epidermal

In *A. thomsoni* four types of development can be distinguished: (a) The initial elongates

and forms a unicellular hair. (b) The terminal cell undergoes periclinal divisions forming 2 to 4-celled uniseriate hairs (Fig. 1, P). (c) At the 2-celled stage, the upper cell undergoes two periclinal divisions and forms a 2-celled stalk and a capitate head (Fig. 1, D). The latter segments anticlinally forming 2 (Fig. 1, E, J), 4 (Fig. 1, F, K) and multi-celled heads (Fig. 1, L). (d) The terminal cell (Fig. 1, G) repeatedly divides periclinally to form a 3 or 4-celled stalk and a 1-celled head (Fig. 1, H). The latter divides anticlinally and produces a capitate structure (Fig. 1, I). The basal cell, in all the four types, usually remains 1-celled but, occasionally, divides anticlinally to form a 2 or 4-celled foot (Fig. 1, H, P).

The distribution pattern of these trichomes is interesting. Types (a) and (b) are usually found on calyx and bracts; type (c) frequently occurs on the style, sometimes on anther, filament and calyx. Type (d) is abundant on the corolla; less frequent on ovary wall and stamen (Fig. 1, M-O).

The studies on the ontogeny and distribution of various types of hairs have been useful in the systematics of the Icacinaceae (Heintzelman and Howard<sup>5</sup>). Similar comparative ontogenetic studies of the trichomes in the Scrophulariaceae may prove useful for taxonomic consideration.

It gives me great pleasure to thank Dr. M. R. Vijayaraghavan for guidance and encouragement.

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Delhi-7 (India), July 29, 1968.

## FLORAL ANATOMY OF *XYRIS INDICA* L.

THE Xyridaceae is a small interesting family of chiefly marshy plants. Taxonomists have differently evaluated the phyletic position of this family. Hutchinson<sup>1</sup> considers it to be "a very advanced or climax group of the Calyciferae." Lawrence<sup>2</sup> in his comparative resume of certain of the families of the Farinosae observes that the Xyridaceae "is perhaps more closely related to Mayacaceae, Eriocaulaceae and the Commelinaceae." Since anatomical investigations of the flower in this family do not appear to have been undertaken so far, it was thought worth while to put on record the observations made on the course of the vascular bundles in the flower of *Xyris indica* L.

The material was collected at Ernakulam by one of us (R. M. P.) in October 1965 and fixed in F.A.A. Serial transections (10-12  $\mu$  in thickness) have been stained in crystal violet using erythrosin as a counter stain.

The pedicel contains two rings of vascular bundles, each of three discrete strands (Fig. 1). The bundles of the outer ring divide into outer and inner strands. The outer one is the median bundle of the sepal (Fig. 2). The inner one divides into three bundles, the lateral two extending upwards as the marginal bundles of the adjacent petals while the median one is the outer staminal strand. Each of the bundles of the inner ring bears an outer branch on the alternating radii which divides into outer and inner strands (Fig. 2). The outer one is the median bundle of the petal while the inner, the inner staminal strand. The remaining vascular tissue of the inner ring is organized into three carpellary dorsals and a central placental cord.

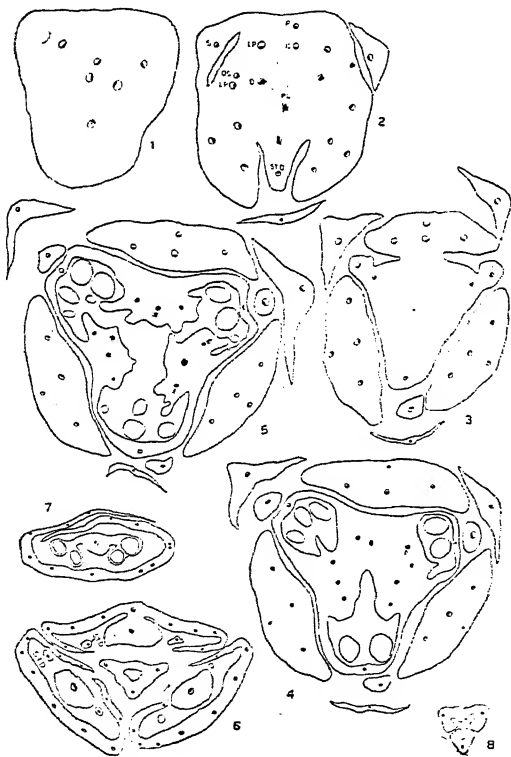
Of the sepals, the odd one is very narrow and extends in some of the flowers for a short length. According to taxonomic accounts,<sup>1,2</sup> the sepals may be three or two, the latter number appearing obviously due to loss. In the present plant, the condition may be showing a trend in reduction of the median sepal. It is worthy of note in this connection that each of the sepals is a one-trace organ (Figs. 2-5), while the petals receive three traces (Fig. 3). The members of the outer whorl of the androecium are reduced to bifid

1. Carlquist, S., *Am. J. Bot.*, 1958, **45**, 675.
2. —, *Ibid.*, 1959 a, **46**, 70.
3. —, *Ibid.*, 1959 b, **46**, 300.
4. Farooq, M. and Siddiqui, S. A., *Beitr. Biol. Pflanzen*, 1966, **42**, 353.
5. Heintzelman, C. E. and Howard, R. A., *Am. J. Bot.*, 1948, **35**, 42.
6. Metcalfe, C. R. and Chalk, L., *Anatomy of the Dicotyledons*, Oxford, 1950, 2.
7. Mathur, Sneh Lata, *Curr. Sci.*, 1961, **30**, 471.
8. Ramayya, N., *Ibid.*, 1963, **32**, 27.

hairy staminodes (Fig. 6). The inner three functional members are adnate to the petals. The anthers are extrorse. The bundle in the connective is amphicribal (Fig. 7).

The superior ovary at the base is trilobular for a short length (Fig. 4) and unilocular above with three parietal placentæ (Fig. 5). It is well known that in many angiosperm species with unilocular ovaries, a basal multi-locular condition may be met with. The central placental cord divides into a number of bundles which send branches to the numerous ovules (Fig. 5).

The style receives the three carpellary dorsals and is three-branched. Each branch contains a dorsal bundle (Fig. 8).



FIGS. 1-8. Serial transsections of the flower of *Xyris indica* L. from the base upwards. D—Carpellary dorsal; IS—Inner staminal strand; LP—Lateral trace of a petal; OS—Outer staminal strand; P—Median bundle of a petal; PL—Placental strand; S—Median bundle of a sepal; STD—Staminode.

The reduction of the androecium is of some interest. It is the antesealous outer whorl

that suffers suppression here. Even in the Mayacaceæ,<sup>2</sup> the stamens are three and alternate with the petals. However, in comelinaceous plants,<sup>3</sup> members belonging to either whorl are arrested and the number of functional stamens is sometimes, in such cases, also three.

The authors are grateful to Professor K. B. Deshpande for his helpful interest.

Dept. of Botany, G. M. TUKSHETTY.  
Marathwada University, JAYASHREE KULKARNI.  
Aurangabad, R. M. PAI.  
July 30, 1968.

1. Hutchinson, J., *The Families of Flowering Plants*, 1959, 2.
2. Lawrence, G. H. M. *Taxonomy of Vascular Plants*, 1951.
3. Morton, J. K., *J. Linn. Soc. Bot.*, 1963, 59, 431.

#### A NEW DEVICE FOR MAKING IMPRINTS

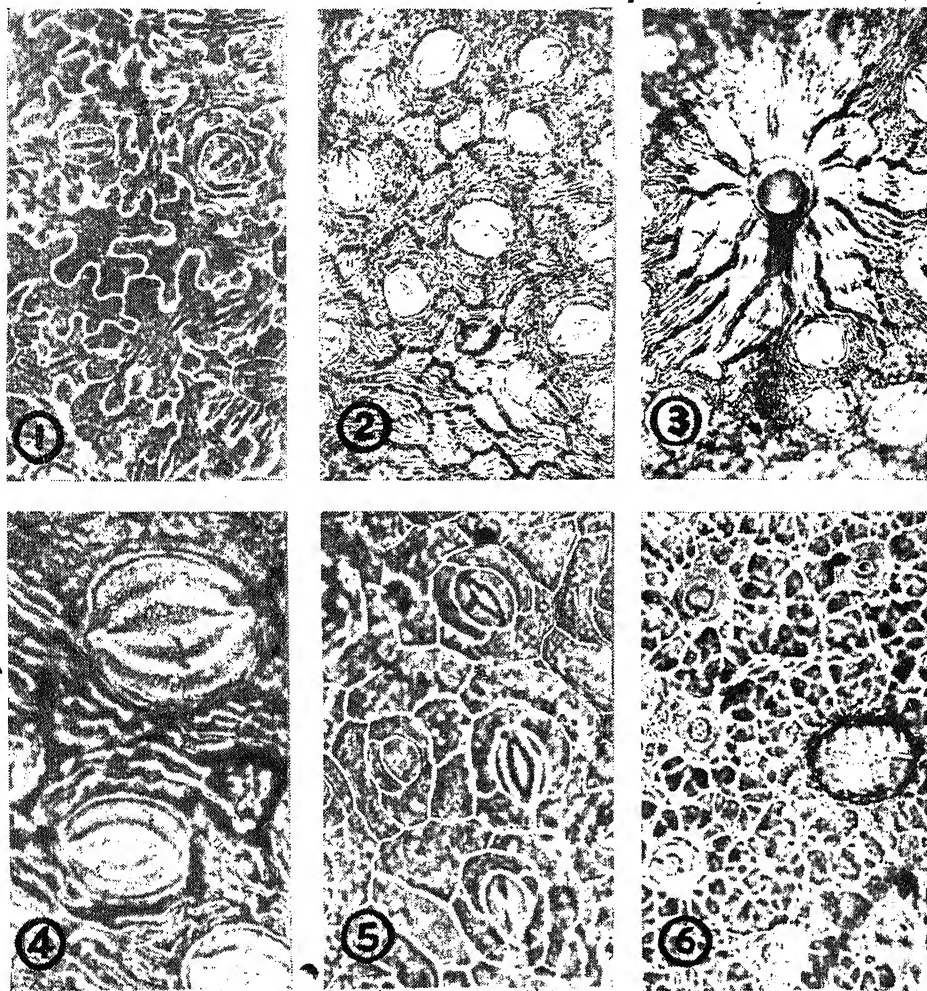
THE customary method for studying the epidermal structures is preparing peels. Present-day techniques<sup>1</sup> for getting the imprints involve the use of silicone rubber latex, cellulose acetate and Rhoplax AC-33—an acrylic polymer emulsion. A new device described here is by the use of mucilage from the unripe fruits of *Coccinia cordifolia* Cogn.

The mucilage obtained by making incisions in the unripe fruits is transferred to the surface of the leaves of which imprints are to be prepared, spread with the help of a needle into uniform film. The leaves are then kept in open air for drying. In about 5-20 minutes depending upon external conditions and the leaf material, a dry thin film is ready to be peeled off. With a fine forceps or a needle, the film is removed carefully, put on the microscope slide and covered with a cover glass. The imprinted surface should be in contact with cover glass. The slide is then sealed by Dunlop rubber solution and is now ready for microscopic observations.

The above technique applied to study the epidermal structures of the leaves of *Clerodendrum splendens* G. Don (Fig. 1), *Diospyros cordifolia* Roxb. (Figs. 2-4), *Hibiscus rosasinensis* Linn. (Fig. 5) and *Mangifera indica* Linn. (Fig. 6) gave satisfactory results.

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Vallabh Vidyanagar,  
Gujarat State (India), March 28, 1968.

R. J. PATEL.



FIGS. 1-6. Microphotographs of imprints showing the epidermal structures. Fig. 1. *Clerodendrum splendens* G. Don,  $\times 397$ . Figs. 2-4. *Diospyros cordifolia* Roxb. (Figs. 2-3,  $\times 397$ ; Fig. 4,  $\times 960$ ). Fig. 5. *Hibiscus rosasinensis* Linn.,  $\times 397$ . Fig. 6. *Mangifera indica* Linn.,  $\times 397$ .

sis Linn. (Fig. 5) and *Mangifera indica* Linn. (Fig. 6) gave satisfactory results.

## REVIEWS AND NOTICES OF BOOKS

**The Stereochemistry of Macromolecules** (Vol. 3). Edited by A. D. Ketley. (Marcel Dekker, Inc., 95, Madison Avenue, New York), 1968. Pp. xiii + 460. Price \$21.75.

Most synthetic polymers contain either asymmetric atoms or double bonds which can give rise to geometrical isomers. As long as thirty years ago, the problem of stereoisomerism in polymer chains was discussed. However, the field lay dormant since, at that time, it was not possible either to synthesize polymers which were highly stereoregular or to measure the degree of regularity in the chains of those polymers which were known. It was not until Natta showed that transition-metal-based catalysts could exert a very high degree of steric control in the polymerization of simple olefins and a wide variety of other monomers that this field became a major area of research.

In Volume 1 of this three-volume series, attempts have been made to bring together the latest knowledge of Ziegler-Natta polymerization. Volume 2 deals mainly with the stereospecific polymerization of monomers by catalysts other than the Ziegler-Natta type.

The contents of this volume are: Chain Conformation and Crystallinity; High-Resolution Nuclear Magnetic Resonance of Synthetic Polymers; Vibrational Analyses of the Infrared Spectra of Stereoregular Polypropylene; Optically Active Stereoregular Polymers; Physical Properties of Stereoregular Polymers in the Solid State; Properties of Synthetic Linear Stereoregular Polymers in Solution; Macromolecules as Information Storage Systems; Automata Theories of Hereditary Tactic Copolymerization; The Effect of Microtacticity on the Reactions of Polymers; and Degradation of Stereoregular Polymers.

C. V. R.

**Eye Movements and Vision.** By Alfred L. Yarbus. (Plenum Press, New York), 1967. Pp. xiii + 222.

This book deals with the perception of images which are strictly stationary relative to the retina, the principles governing human eye movements, and the study of their role in the process of vision.

The book is based on the results of the author's experimental investigations. During the course of his experiments, he developed a suction device that can be attached to the human eye and used to hold a miniature optical system. The optical system serves in most experiments to stimulate the eye with patterns of light. Since the stimulating apparatus is mounted on the eye, the patterns move with the eye and hence permit the study of vision in the presence of stationary patterns on the retina. This produces an "empty visual field" in which the patterns disappear partially or completely from view.

The author provides a new approach to some areas of physiological optics and establishes certain links and analogies between electrophysiological investigations of the retina in animals and studies of human vision.

The book will be of interest to students and researchers in the fields of biophysics, physiology, medicine, psychology, and branches of technology such as television, motion pictures, and apparatus construction.

C. V. R.

**Biochemistry of Bacterial Growth.** Edited by J. Mandelstam and K. McQuillen. (Blackwell Scientific Publications, Oxford and Edinburgh), 1968. Pp. x + 540. Price 84 sh. net.

This introductory book is intended both for undergraduates and for those coming to microbiology after a training in some other field. The guiding consideration has been to provide the reader with a coherent picture of the biochemistry of bacterial growth. The subject is presented first as a condensed description of the events occurring during growth of a 'generalized' bacterial cell in a simple medium; degradation of the carbon source to give basic carbon skeletons; the synthesis from these of basic metabolites (amino-acids, nucleotides, etc.); and the assembly of the metabolites into macromolecules. There is also an outline of metabolic regulation. Basic concepts ('coding problem', DNA replication, etc.) are presented at this stage. The second and major part of the book is an expanded treatment of the same material in which each chapter is written by a specialist in the field. In addition, this section includes chapters on genetics, sporulation and classification.

C. V. R.



**The Millipede *Thyropygus*.** By G. Krishnan. Publication and Information Directorate, Council of Scientific and Industrial Research, Hillside Road, New Delhi-12, 1968. Pp. 84. Price Rs. 12 or 24 sh. or \$3.50.

The present publication is the first of the series in the CSIR Zoological Memoirs on Indian Animal Types. The series is intended to provide guides for teaching of zoology in colleges. *Thyropygus poseidon* is an animal type included in graduate study of zoology. The author has dealt in detail with the taxonomy, anatomy, reproduction, development and habits of this millipede. He has also included a useful section on directions for practical work on this type. The book contains 44 text-figures.

A. S. G.

### ANNOUNCEMENTS

#### Seminar on Structural Crystallography

The Centre of Advanced Study in Biophysics and Crystallography, University of Madras, will be holding their annual Seminar on the 5th, 6th and 7th February 1969 at Madras. Contributions in the form of papers are invited on any topic related to Structural Crystallography. An abstract in about 200 words should be sent to Professor R. Srinivasan who may also be contacted for any further particulars required, University of Madras, Centre of Advanced Study in Biophysics and Crystallography, A.C. College Buildings, Madras-25.

#### Birbal Sahni Institute of Palaeobotany, Lucknow

The Twenty-first Annual Scientific Meeting of the Palaeobotanical Society will be held at the Institute's premises on the 21st, 22nd and 23rd January, 1969.

#### Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Physics to Shri G. R. Mohan Rao; Ph.D. degree in Nuclear Physics to Shri K. Appalacharyulu and Ph.D. degree in Chemistry to Shri M. Gopala Rao.

Utkal University has awarded the Ph.D. degree in Chemistry to Shri Satyabrata Misra.

Sri Venkateswara University has awarded the Ph.D. degree in Botany to the following: Shri M. Sanjiva Reddy, Shri A. Jayarami Reddy

and Shri P. Mallikarjuna Swamy; Ph.D. degree in Zoology to Shri M. V. Subba Rao.

### Books Received

**Plant Virus Names—An Annotated List of Names and Synonyms of Plant Viruses and Diseases.** Edited by E. B. Martyn. (Commonwealth Mycological Institute, Kew, Surrey, England), 1968. Pp. ix + 204. Price 30 sh.

**Chemical Bonds in Semiconductors and Thermodynamics.** Edited by Ac. N. N. Sirota. (Plenum Pub. Corp., New York 10011), 1968. Pp. xi + 255.

**Quantum Electronics in Lasers and Masers.** By Academician D. V. S. Kobel Toyn. (Plenum Pub. Corp., New York 10011), 1968. Pp. vii + 161.

**Macro and Semi Micro Chemical Analysis Without  $H_2S$  Using Potassium Trithiocarbonate.** By K. N. Johri. (Asia Publishing House, Bombay-1), 1968. Pp. xii + 76.

**Hand-Book of Rock Gardening on the Hills.** By P. Kachroo. (Indian Council of Agricultural Research, New Delhi-1), 1968. Pp. viii + 90. Price Rs. 5-20.

**The Stereo-Chemistry of Macromolecules (Vol. 3).** Edited by A. D. Ketley (Marcel Dekker, 95 Madison Avenue, New York, N.Y. 10016), 1968. Pp. xiii + 460. Price \$21.75.

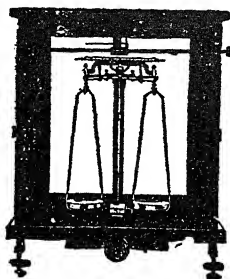
**Proceedings of the Summer Seminar in Fluid Mechanics, May 1967.** Edited by P. L. Bhatnagar. (Department of Applied Mathematics, Indian Institute of Science, Bangalore-12), 1968. Pp. 479. Price Rs. 34-50 or \$6.00 or 45 sh.

**Auto Eugenics and Sex Predetermination.** By S. S. Verdi. (Kanwal Pal and Co., 312, Sector 20 A, Chandigarh-20), Pp. 122. Price not given.

**General Entomology.** By M. S. Mani. (Oxford and IBH Pub. Co., 17 Park Street, Calcutta-16), 1968. Pp. xii + 501. Price Rs. 18-00.

**Physiologie und Biochemie der Mikroorganism.** By Jiri Starka. (VeB Gustav Fischer, Verlag, JENA), 1968. Pp. 608. Price Geb. M. 98.

**Studies in Indian Agriculture—The Art of the Possible** (Translated from the French by M. Mothersole). By G. Etienne. (Oxford University Press, Mount Road, Madras-2), 1968. Pp. xii + 343. Price Rs. 35-00.



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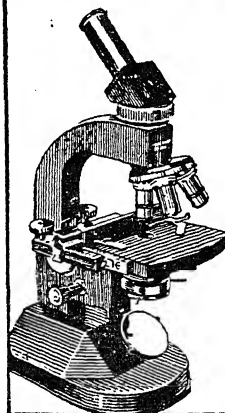
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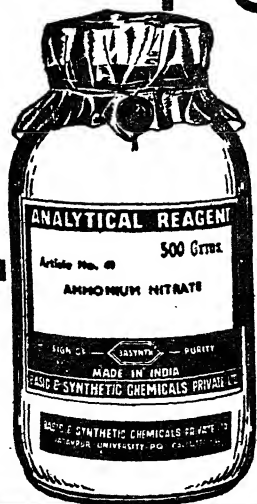
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# ALTERATION OF THE MUTATION SPECTRUM IN BARLEY THROUGH TREATMENTS AT DIFFERENT PERIODS IN THE S PHASE OF DNA SYNTHESIS

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Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi

**C**HANGING the spectrum of mutations in a predictable manner and thereby achieving directed mutagenesis is an important goal of current mutation research.<sup>1,2,5,11,13</sup> Nilan<sup>9</sup> has reviewed the various reports of alteration in spectrum induced by specific mutagens or treatment conditions and has concluded that different mutagens and treatment procedures may induce some changes in the relative proportions of different types of mutations in higher plants. However, a precise control over mutation spectrum is yet to be achieved. Data are now available which indicate conclusively that when cells are treated with chemical mutagens such as Ethyl methane sulphonate (EMS) during the S phase of DNA synthesis, the mutation frequency is significantly higher.<sup>6,7,10</sup> Recently, Creda-olmedo and Hanawalt<sup>3</sup> found in *Escherichia coli* treated with N-methyl-N-nitro-N-nitrosoguanidine, that the maximum frequency of a given type of mutation occurs when the treatment is given at the time the gene is being replicated. It is also established now from studies in different test organisms, both plants and animals including man, that the DNA replication along a chromosome is asynchronous in time sequence. In some chromosomes the replication commences from the centromere and proceeds towards the telomere; in others the reverse happens. The possibility is thus open for affecting groups of loci preferentially by administering the treatment for short periods (pulse treatments) at different stages of S phase. In the present study, an experiment was undertaken to test the validity of this hypothesis.

In barley seeds germinated at 22° C., the S phase starts after about 16 hours of soaking in water as determined by the incorporation of <sup>3</sup>H-thymidine and lasts for 4 hours.<sup>10</sup> Based on this observation, seeds of the barley variety N.P. 104 were soaked in distilled water at 22° C. for 16 hours. Starting from 16 hours of soaking when the S phase commences, the wet seeds were treated with 1% aqueous solution of EMS for 30 minutes. At the end of the treatment period, the seeds were washed in running water for 2 hours and then sown in a seedbed. Soaking in water also helps to create an anoxic condition and thereby a

considerable degree of synchrony in division. Treatments were given in this way during 8 different stages of the S phase. Each M<sub>1</sub> plant was selfed and seeds were collected from the main and secondary tillers separately. The M<sub>2</sub> generation was raised as spike to row progeny and the population was scored carefully for chlorophyll mutations (Table I).

TABLE I  
Chlorophyll mutation spectrum in barley  
EMS : 1% for 30 minutes

Hrs.	Mins.	Hours of pre-soaking	No. of M <sub>2</sub> spike progenies	No. of M <sub>2</sub> seedlings scored	Total no. of chlorophyll mutants	Number of mutants of type				
						<i>Albina</i>	<i>Viridis</i>	<i>Chlorina</i>	<i>Xantha</i>	<i>Striata</i> <i>Tigrina</i>
16	00	423	13,011	86	36	22	22	0	6	0
16	30	341	8,916	58	28	17	13	0	0	0
17	00	287	8,594	85	40	13	17	15	0	0
17	30	363	11,845	140	51	19	4	47	2	17
18	00	262	8,869	134	60	22	15	27	4	6
18	30	362	10,399	88	33	13	14	23	5	0
19	00	276	8,823	44	12	16	14	2	0	0
19	30	209	5,624	34	16	14	2	1	0	1

The data reveal that *xantha* mutant begins to appear only in treatments made 60 minutes after the onset of the S phase. *Tigrina* appears in the next treatment phase. *Albina*, *viridis*, *striata* and *chlorina* types occur in several treatments and the incidence of these is not confined to any particular fraction of the S phase. The complete absence of *xantha* in the first hour and its subsequent appearance in large numbers was the most conspicuous feature of this S phase fractionation experiment.

A major difficulty in the interpretation of such results is that a single phenotype may be governed by several loci. Thus, 250 to 300 loci are believed to be involved in chlorophyll synthesis in barley.<sup>8</sup> Gustafsson<sup>4</sup> suggested that 125 to 150 loci may be concerned with *albina*, 125 with *viridis*, 10 to 15 with *xantha* and 15 to 20 with rare types. Von Wettstein<sup>12</sup> found that the three *xantha* loci studied by him were allelic. The genetics of *xantha* determination thus appears to be relatively more simple than that of *albina*, *viridis*, or *chlorina*. The specificity observed with regard

to the time dependence of its appearance may be due to the relatively few loci involved.

The effects of short duration treatments during the S phase are now being studied with simply inherited marker characters, both linked and unlinked. For this technique to be effectively used, bringing about a high degree of synchronisation of cell division, rapid diffusion of the mutagen and an effective evacuation of the mutagen at the end of the treatment period are essential. It is possible that loci which are not in the S phase may also be affected by the mutagen and hence only the relative frequencies of different classes of mutations can possibly be modified through this approach. The data of the present study are sufficiently promising to warrant a more detailed probe of the use of this technique in altering mutation spectrum.

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1. Auerbach, C., In *Chemische Mutagenese*, Erwin-Baur Gedächtnissymposium. I., Ed. Stubbe, H., Akademik Verlag, Berlin, 1960. p. 121.
2. —, *Science*, 1967, **153**, 1141.
3. Creda-olmedo, E. and Hanawalt, P. C., In *Cold Spring Harbor Symp. Quant. Biol.*, 1968 (Abst.), **33**, 63.
4. Gustafsson, Å., *Proc. Symp. Radiobiology*, Liege, 1956, p. 282.
5. —, *Heredity*, 1963, **50**, 211.
6. Mikaelson, K., Ahnstrom, G. and Li, W. C., *Ib.d.*, *ditas*, 1968, **59**, 353.
7. Natarajan, A. T. and Shivasankar, G., *Z. Vererbungsl.*, 1965, **96**, 13.
8. Nilan, R. A., *Monographic Suppl. No. 3* Washington State Univ., 1964, **32**, 1-278.
9. —, *Proc. Symp. On Induced Mutations and Their Utilization* (Berlin, 1966) (Publ.), 1967, p. 5.
10. Savin, V. N., Swaminathan, M. S. and Sharma, B., *Mutation Res.*, 1968, **6**, 1010.
11. Smith, H. H., In *Mutation and Plant Breeding Publ. No. 991*, NAS-NRC, Washington, D. C., 1960, p. 413.
12. Von Wettstein, D., *Heredity*, 1960, **46**, 700.
13. Westergaard, M., In *Chemische Mutagenese*, Akademik Verlag, Berlin, 1960, p. 116.

## STUDIES ON GROWTH AND MUTATION FREQUENCY IN RICE IN TREATMENTS WITH DIMETHYL SULPHOXIDE AND ETHYL METHANE SULPHONATE

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THE introduction of dimethyl sulphoxide (DMSO), as a carrier in medicine<sup>4,6</sup> and a solvent in biological works,<sup>3</sup> has aroused much interest in the field of chemical mutagenesis.<sup>1,2</sup> Earlier reports on DMSO emphasized its low toxicity and absence of any detectable side effect as a result of interaction with several drugs and aromatic compounds<sup>5,10,13</sup> in particular. Probably this led Bhatia<sup>1,2</sup> to assess its potentiating effect on chemical mutagens. The enhanced mutation frequency associated with a high percentage of survival in *Arabidopsis thaliana* realized by Bhatia<sup>1,2</sup> led the present authors to make use of the penetrant-carrier in rice in which the husk hinders the easy and rapid uptake of chemical mutagens.

Swaminathan *et al.*<sup>11</sup> concluded from preliminary studies that DMSO treatment was as toxic as any other chemical mutagen in rice. A more detailed study on the effect of DMSO alone and in combination with EMS carried out since then is presented in this paper.

The unhulled seeds of Tainan-3, a *japonica* variety of *O. sativa* presoaked in water for

eight hours were treated with different concentrations of DMSO and DMSO + EMS. The effect of various treatments was measured as percentage reduction of germination, survival and seedling injury in the M<sub>1</sub> generation. The chlorophyll mutation frequency in the M<sub>2</sub> of a lot (seeds presoaked for 16 hours in water followed by treatment with EMS and EMS + DMSO for one hour) has been included so as to assess the effect of the penetrant-carrier on the mutation frequency.

The effect of DMSO alone as measured by the rate of germination, survival and growth rate indicated the carrier to possess local toxicity which followed a linear relationship with the concentration. At lower concentrations, the percentage of germination and survival was either on par with that of control or a little exceeded. However, data on growth rate showed proportionate decrease with increasing dose (Table I). Another feature of interest was that the percentage of seeds showing delayed germination increased with increasing concentration. It is known that higher concentration of DMSO causes high incidence of

lethality in *Arabidopsis*<sup>1,2</sup> and decrease in spore germination in *Lycogala epidendrum*. DMSO, at its lower concentration, has also been reported to accelerate the process of spore

TABLE I  
Effect of DMSO on germination survival and seedling injury  
(Tainan 3)

Treatment	Treatment period	No. of seeds sown	% of seeds germinated		% of seedlings survived	Shoot length on 10th day in cm.
			5th day	10th day		
Control	..	100	86	95	90	9.19
DMSO (%)	8 hrs.	100	84	94	91	8.14
1.0	..	100	88	99	94	7.26
2.5	..	100	84	93	90	6.97
5.0	..	100	82	92	87	6.64
10.0	..	100	69	89	78	5.75
20.0	..	100	52	85	71	4.52
30.0	..	100				

germination.<sup>12,14</sup> The present findings also indicate that though DMSO possesses local toxicity, it could enhance the percentage of germination or survival at low concentration levels. However, irrespective of the concentration levels the inherent toxicity was found to be manifested in growth rate. Recent studies of Shilkin *et al.*<sup>9</sup> and Kocsis *et al.*<sup>7</sup> in animal tissues emphasised that DMSO has its local toxicity which is relatively higher in its undiluted form.

Considering the possibility that DMSO facilitates the rapid uptake of chemicals by increasing the membrane permeability, several workers studied the potentiating effect of the carrier. Sciuchetti and Born<sup>8</sup> found that DMSO apparently enhances the response of *Datura tatula* to a growth retardant when it was combined with the retardant. Kocsis *et al.*<sup>7</sup> have clearly demonstrated that DMSO markedly potentiated the toxicity of several aromatic hydrocarbons. The present findings on the effect of DMSO in combination with EMS, indicated, quite in agreement with the earlier reports, a tremendous influence of DMSO in enhancing the effect of EMS as measured by the percentage of germination, survival and growth rate in the  $M_1$  generation (Tables II and III). The degree of potentiating effect appears to increase with increase in the concentration of DMSO. This again is in conformity with the views of Kocsis *et al.*<sup>7</sup> that the potentiating effect on toxicity is very much reduced when DMSO is applied in its diluted form.

TABLE II  
Effect of DMSO at different concentrations when combined with EMS  
(Tainan 3)

Treatment	Treatment period	No. of seeds sown	% of seeds germinated		% of seedlings survived	Shoot length on 10th day in cm.
			5th day	10th day		
Control	..	100	93	95	91	8.58
EMS 0.4%	.. 8 hrs.	100	87	92	85	5.30
DMSO + EMS (1%)	..	100	94	97	93	5.98
DMSO + EMS (2.5%)	..	100	90	90	88	5.02
DMSO + EMS (5%)	..	100	87	87	76	4.20
DMSO + EMS (10%)	..	100	82	86	75	3.39
DMSO + EMS (20%)	..	100	78	87	69	2.48
DMSO + EMS (30%)	..	100	73	73	64	1.72

TABLE III  
Effect of DMSO in combination with EMS  
(Tainan 3)

Treatment	Treatment period	No. of seeds sown	% of seeds germinated		% of seedlings survived	Shoot length on 10th day in cm.
			5th day	10th day		
Control	.. 3 hrs.	300	80.3	97.0	95.0	10.82
DMSO 5%	..	300	84.0	97.3	95.6	9.79
EMS (1%)	..	300	53.0	89.0	83.0	6.58
DMSO (5%) + EMS (1%)	..	300	2.0	57.0	43.0	4.21

The effect of DMSO in enhancing the mutagenic efficiency of chemical mutagens was first reported by Bhatia<sup>1,2</sup> in *Arabidopsis thaliana*. However, the present study on rice, though on a limited scale, suggested that the mutation frequency, as measured on  $M_2$  population basis, remained more or less same both in EMS and EMS + DMSO treatments (Table IV). This

TABLE IV  
Frequency of chlorophyll mutations  
(Tainan 3)

Treatment	Treatment period	No. of $M_1$ plant progenies	% of mutants in the $M_2$ population
Control	..	25	0
DMSO 5%	.. 1 hr.	77	0
EMS (1%)	..	45	2.21
DMSO (5%) + EMS (1%)	..	61	2.08

observation though contrary to that of Bhatia is to be expected since the membrane permeability might have reached the maximum with water presoaking itself and the additional increase in permeability through DMSO might not influence the rate of absorption. Further, it seems that DMSO does not also cause any reduction in mutation frequency.

1. Bhatia, C. R., *Mutation Research*, 1967, **4**, 375.
2. —, *Arabidopsis Information Service*, 1967, **4**, 39.
3. Carter, S. B., *Nature*, Lond., 1967, **213**, 261.
4. Fabianek, J. and Herp, A., *Proc. Soc. Exptl. Biol. & Med.*, 1966, **122** (1), 290.
5. Jacob, S. W., Bischell, M. and Herschler, R. J., *Curr. Therap. Res. Clin. Exp.*, 1964, **6**, 193.

6. Kligman, A. M., *J. Amer. Med. Assoc.*, 1965, **193**, 140.
7. Kocsis, J. J., Harkaway, Sant'oya, M. C. and Snyder R., *Science*, 1963, **160**, 427.
8. Sciuchetti, L. A. and Born, A. E., *J. Pharm. Sci.*, 1965, **54** (2), 285.
9. Shilkin, K. B., Papadimitriou, J. M. and Walters, M. N. I., *Australian J. Expt. Biol. Med. Sci.*, 1966, **44** (5), 581.
10. Smith, E. R., Hadidian, Z. and Mason, M. M., *Ann. N. Y. Acad. Sci.*, 1967, **14** (1), 96.
11. Swaminathan, M. S., Siddiq, E. A., Singh, C. B. and Pai, R. A., *Proc. 4th Co-ordinating Meeting of the FAO/IAEA Co-ordinated Programme in the Use of Induced Mutations in Rice Breeding*, 1968.
12. Widdowson, J. P., *Nature*, Lond., 1967, **214**, 812.
13. Willson, J. K., Brown, D. E. and Timmens, E. K., *Toxicol. Appl. Pharmacol.*, 1965, **7** (1), 104.
14. Winifred Butter Field, *Nature*, Lond., 1968, **218**, 494.

## LIQUID METAL MAGNETOHYDRODYNAMIC POWER GENERATOR

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THE theoretical aspect of magnetohydrodynamic power generator using a rectangular channel of uniform cross-section is investigated in this article. The experimental arrangements and the results obtained will be presented elsewhere. The physical problem consists of the flow of a conducting, incompressible, heterogeneous and non-viscous fluid bounded by a rectangular channel made of electrodes and insulating walls in the presence of a transverse magnetic field. The purpose of using an heterogeneous conducting fluid is to achieve increased power output.

The required equations following Rudraiah (1964), using

$$u_x = u \left( \frac{\rho}{\rho_0} \right)^{\frac{1}{2}} \quad (1)$$

$$u_y = v \left( \frac{\rho}{\rho_0} \right)^{\frac{1}{2}} \quad (2)$$

and using small perturbation

$$\begin{aligned} u_x &= u' + U \\ u_y &= v' \end{aligned} \quad (3)$$

where  $u$  and  $v$  are the  $x$  and  $y$  components of velocity,  $\rho$  is the variable density,  $\rho_0$  is some reference density, and  $U$  is the free upstream velocity, become

$$\nabla^2 \Phi = N \left[ \frac{\partial \Phi}{\partial \xi} + \left( \frac{\rho_0}{\rho} \right)^{\frac{1}{2}} \frac{\partial \Psi}{\partial \xi} \right] \quad (4)$$

$$\nabla^2 \Psi = -N \left[ \frac{\partial \Phi}{\partial \xi} + \left( \frac{\rho_0}{\rho} \right)^{\frac{1}{2}} \frac{\partial \Psi}{\partial \xi} \right] \quad (5)$$

with the boundary conditions

$$\Phi = \pm \Phi_0 \quad \zeta = \pm \frac{\pi}{2h} \quad (\xi > 0) \quad (6)$$

$$\frac{\partial \Phi}{\partial \xi} = 0 \quad \zeta = \pm \frac{\pi}{2h} \quad (\xi < 0) \quad (7)$$

$$\Psi = \pm \frac{\pi}{2h} \quad \zeta = \pm \frac{\pi}{2h} \quad (-\infty < x < \infty) \quad (8)$$

where

$$\phi = UBh\Phi, \quad \psi' = Uh\Psi, \quad x = h\xi$$

and  $y = h\zeta$ ,  $\phi$  is the electric potential and  $\psi'$  is the stream function,

$$N = \frac{\sigma B^2 h}{\rho_0 U}$$

is the interaction parameter, which we assume to be small.

To solve equation (4) we use,

$$\Phi = \Phi_0 + N\Phi_1 + \dots \quad (9)$$

$$\Psi = \Psi_0 + N\Psi_1 + \dots \quad (10)$$

$$\rho = \rho_0 + N\rho_1 + \dots \quad (11)$$

We note that  $\Phi_0$  is sufficient (Sutton and Carlson, 1961) to calculate the power output. Thus, equation (4) is solved using the technique of conformal mapping, where we use the transformation

$$e^z = \sin w \quad (12)$$

$$\eta_h = \xi + \frac{\pi}{2h} \quad (13)$$

$$z = \xi + i\eta_h \quad (14)$$

$$w = \xi' + i\eta_h', \quad \eta_h = \frac{\eta}{h} \quad (15)$$

The required solution for the potential is

$$\Phi_0 = 2\Phi_w \frac{\xi'h}{\pi} \quad (16)$$

or in terms of dimensional quantities

$$\phi_0 = 2\phi_w \frac{x'}{\pi} \quad (17)$$

where

$$\xi' = \frac{x'}{h} \quad \eta_h' = \frac{\eta'}{h}$$

The expression for the current, using Ohm's law, will be

$$J_0 = \frac{2\sigma}{\pi} \phi_w \eta' - \left(\frac{\rho_0}{\rho}\right)^{\frac{1}{2}} \sigma UBx. \quad (18)$$

For large  $\eta'$  along  $x = \pi/2$ , equation (12) becomes

$$e^x = \frac{1}{2} e^{\eta'} \quad (19)$$

and hence

$$\eta' = x + \log 2. \quad (20)$$

If the channel length is  $L$ , the total current to the electrodes per unit length in the direction of the magnetic field is

$$J_L = \sigma \left[ \frac{2\phi_w}{h} - \left(\frac{\rho_0}{\rho}\right)^{\frac{1}{2}} UB \right] L + \frac{4}{\pi} \sigma \phi_w \log 2. \quad (21)$$

The efficiency of the power generator is given by

$$\epsilon_g = \frac{\text{Power output}}{\text{Flow work}}$$

$$= \frac{2\phi_w \left[ L \left\{ \frac{2\phi_w}{h} - \left(\frac{\rho_0}{\rho}\right)^{\frac{1}{2}} UB \right\} + \frac{4}{\pi} \log 2 \right]}{UBLh \left(\frac{\rho_0}{\rho}\right)^{\frac{1}{2}} \left[ \frac{2\phi_w}{h} - UB \left(\frac{\rho_0}{\rho}\right)^{\frac{1}{2}} \right]}. \quad (22)$$

If  $L \rightarrow \infty$ , the end losses become negligible and the efficiency becomes

$$\epsilon_g = \frac{2\phi_w}{UBh} \left(\frac{\rho}{\rho_0}\right)^{\frac{1}{2}}. \quad (23)$$

We conclude that using an heterogeneous conducting fluid, the total current per unit length in the direction of the magnetic field, the power output and efficiency are increased.

1. Sutton, G. W. and Carlson, A. W.. "End effects in inviscid flow in a magnetohydrodynamic channel," *J. Fluid. Mech.*, 1961, 2, 121.
2. Rudraiah, N., "Magnetohydrodynamic stability of Heterogeneous dissipative conducting liquids," *Appl. Sci. Res. Sec. B*, 1964, 2, 180.

## OCCURRENCE OF BIVALVE GASTROPODS (MOLLUSCA) IN VISAKHAPATNAM SHORE

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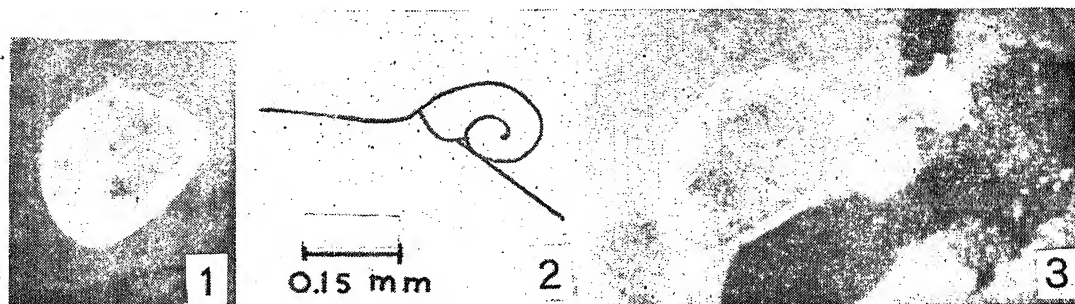
THE bertheliiniids were considered to be an extinct group of bivalve molluscs until Kawaguti and Baba<sup>1</sup> discovered the first living representative of the group *Tamanovalva limax* from Bison Seto, Inland Sea of Japan. The above authors established the true identity of this group as 'bivalve gastropods' with a protoconch and a typical Opisthobranch Sacoglossan radula. Ever since the description of this genus *Tamanovalva* by Kawaguti and Baba there has been a growing interest and an intensive search for the occurrence of these forms in other parts of the world. In recent years as many as eleven species of bivalve gastropods belonging to two families and four genera have been reported from different parts of the world, Australia, California, Hawaii, Jamaica and Puerto Rico. As many as 8 of these belong to the genus *Tamanovalva*. The only previous report of a bertheliiniid from Indian waters was by Prabhakara Rao<sup>2</sup> who obtained four specimens of *Tamanovalva limax* from the green alga *Caulerpa racemosa* from Mandapam, Gulf of Mannar on the east coast of India. In the present communication the authors report the occurrence of three species of *Tamanovalva* of undetermined identity, one from *Caulerpa taxifolia* and two from *Caulerpa racemosa*. The specimens were discovered in

the course of our studies on the systematics and ecology of invertebrate animals associated with the algal vegetation on our foreshore.

A single specimen of *Tamanovalva* sp. was found on the fronds of the siphonous green alga, *Caulerpa taxifolia* collected from the low watermark. The shell is fragile and leaf-green in colour and measured 2.5 mm. in length and 1.95 mm. in height. Faint growth lines were visible on the shell and the periostracum was transparent (Fig. 1). The adductor muscle impression is circular and subcentral. The protoconch or nucleus on the left valve is one and one-half whorls, sharply set off from the rest of the body by its pearly white colour (Fig. 2).

Five more specimens of *Tamanovalva* were recovered from the fronds of *Caulerpa racemosa* of which one was alive. The live specimen (Fig. 3) which measured 8.5 mm. in length, when fully extended, was found attached to the fronds of the alga which it resembled closely in shape and colour. The shell is semicircular and measured 6.6 mm in length and 5.0 mm. in height. The shell is obese with a subcentral bluish-yellow large circular adductor muscle impression. The protoconch was not present and it is presumed to have been lost accidentally. Above the adductor muscle impression are two bright





FIGS. 1-3. Fig. 1. Photograph of *Tamanovalva* sp. (left side) showing protoconch. Fig. 2. A magnified view of the umbone showing the protoconch. Fig. 3. Photograph of living animal with the head extended showing the rhinophores.

shining yellow patches of pigmentation in the mantle irradiating through the transparent shell valves. The surface of the shell at the umbones and the anterior region appeared rough and granular. Yellow rays are present on the shell. The animal having a slug-shaped body survived in the laboratory for 25 days. The rhinophores are short and slender and auriculate. The rhinophores, neck and foot are uniformly yellow in colour and the tips of the rhinophores are speckled with white spots. Two black eyes are present one on either side on an elevation of the neck behind the rhinophores. The oral tentacles are lobiform. The sole is flat and longitudinally grooved throughout its length. The foot is rounded in front, but tapers behind as tail extending to the posterior margin of the shell. When disturbed or irritated with a needle, the animal ejected dense white viscous hypobranchial gland secretion. The animal was found to feed on the fronds of the alga with its rasping radula. Locomotion is effected by the occasional dragging of the shell by the head part. The animal always leaves behind mucous thread on its track.

Associated with the bivalve gastropods were other sacoglossan Opisthobranch gastropods

belonging to taxa *Volvatella*, *Cylindrobulla*, *Oxynoe*, *Lobiger*, *Elysia*.

The specimen of *Tamanovalva* recovered from *Caulerpa taxifolia* and another from *Caulerpa racemosa* were examined by Dr. Robert Burn, Honorary Associate in Conchology, National Museum of Victoria, Melbourne and he is of the view that both the forms may turn out to be two new species of *Tamanovalva* as they do not agree with any of the described species of the genus in all their features. A full description of these forms and the associated animals will be presented elsewhere.

We wish to express our very grateful thanks to Dr. Robert Burn who readily examined the specimens and for his very helpful suggestions. One of us (A. L. N.) is indebted to the Council of Scientific and Industrial Research for the award of a Research Fellowship during the tenure of which the present work was undertaken.

1. Kawaguti, S. and Baba, K., *Biol. J. Okayama Univ.*, 1959, 5, 177.
2. Prabhakara Rao, K., *Nature*, 1965, 208, 404.

## POLLEN GERMINATION AND FORMATION OF CALLOSE PLUGS IN PAPAYA POLLEN TUBES

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IN the last two decades considerable interest has developed in pollen germination studies. The effect of growth substances on both percentage germination and pollen tube growth forms one of the major aspects of such studies. Recent reviews have summarized the individual

papers pointing out the more important facts.<sup>1,2</sup> Some of the significant observations on pollen germination and tube growth of *Carica papaya* (Variety—Hawaiian breakfast) and the effects of certain growth substances on these processes are summarized in this paper.



Fresh pollen from well opened flowers were collected between 8-9 a.m., from the plants growing in the departmental garden. The grains are tricolporate, oblate spheroidal in shape,  $28.5\mu \times 28.5\mu$  in size, with a fairly reticulate exine. Hanging drop culture technique was followed to obtain germination. At the end of 24 hr. period, germination counts as well as tube measurements were obtained and hardly any growth was noticed in the pollen tubes after this period. Cultures were kept under ambient humidity, with temperature of  $28^{\circ}\text{C}$ . Distilled water formed the control medium.

Pollen grains germinated in about one hour after they were dispersed on different media consisting of either stigmatic extract, solutions of sucrose or borax (sodium borate) or one of the growth substances mentioned in Table I. Only the optimum concentrations of different media used are stated in Table I; but at least three concentrations higher or lower than the optimum mentioned were tried and in them the percentage germination and tube length were generally lower. Only one concentration as mentioned in Table I was used for stigmatic extract and in this medium percentage germination and tube length were less than in control medium like in other cases reported earlier.<sup>2,3</sup> All the different substances used except IBA were favourable both for germination and pollen tube growth. When compared with control (45%) or sucrose (72%) media, higher percentage germination was obtained in 2,4-D medium (80%), almost the same in borax (75%) and IPA media (72%), and less in others, the least being in

IBA (42%) medium (Figs. 1-3). In contrast to controls, the tube length increased more than eight times in 2,4-D medium, about 4 times in NAA, 2-3 times in others (Figs. 1, 3). 2-4, D was more effective both for germination (80%) and tube growth than any other substance used. Among the other growth substances, better germination resulted in IPA medium (72%), intermediate condition was seen in 2,4-5 TPA, IAA and NAA media (65%), and lower germination rate resulted in Kinetin (61%), GA (52%) and IBA (42%) media. The increase in percentage germination did not bear any direct correlation with pollen tube length developed in different media. Though percentage germination was same in NAA (1990  $\mu$ ), 2,4-5 TPA (1680  $\mu$ ), and IAA (1150  $\mu$ ) the tube lengths varied as indicated. In Kinetin and GA media germination percentage was less when compared with IAA medium but tube lengths improved (Table I). Thus, these growth substances had varying effects on the two processes, i.e., germination and tube length, as were recorded in earlier cases.<sup>4,5</sup> In certain others a positive correlation is reported between percentage germination and tube length.<sup>6</sup> Also it seems that while sucrose increases the percentage germination, the growth substances and borax are effective in increasing tube length.

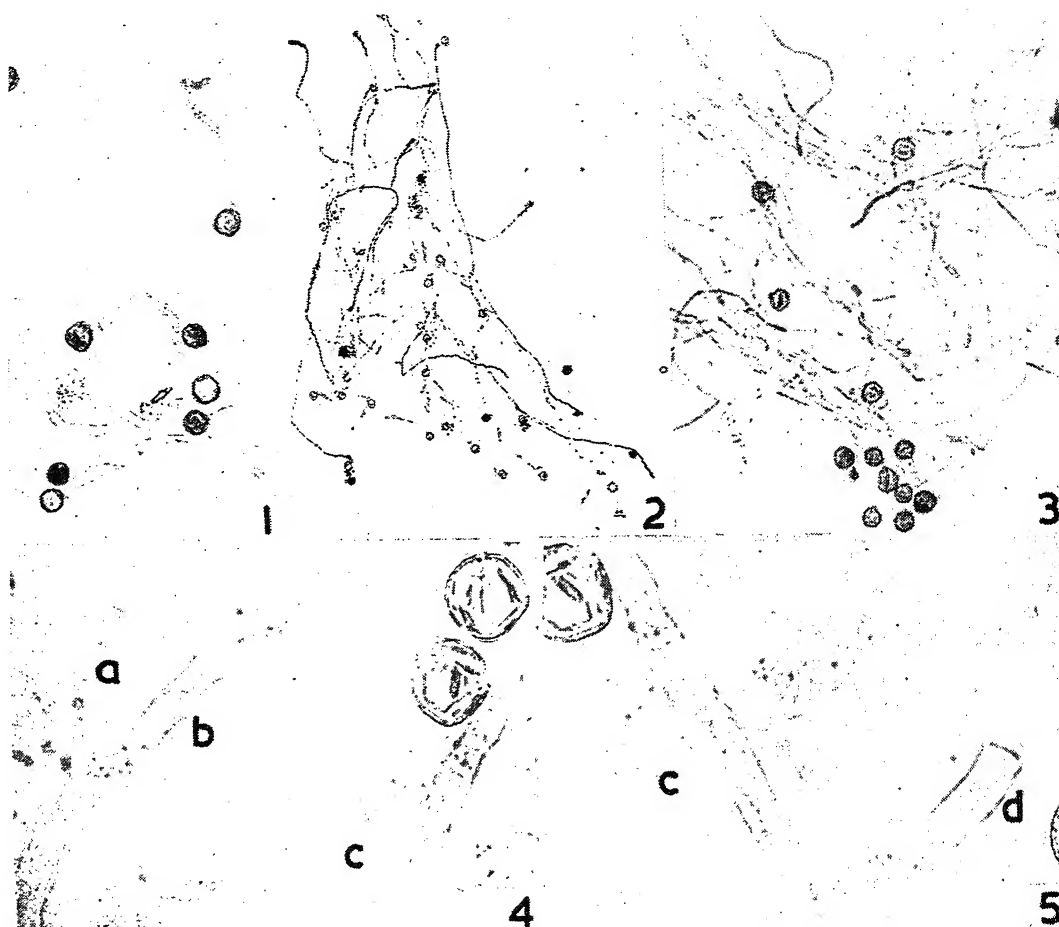
Previously, pollen germination has been studied in the American varieties of papaya. They used agar-sucrose basic medium and analysed the individual effect of vitamins, amino-acids, IAA and sodium borate.<sup>7-8</sup> Many of the substances they used were found to be either inactive in inducing pollen germination or they only induced lower percentage germination than reported here.

Pollen of *Carica papaya* are monosiphonous and tubes grown in distilled water and sucrose had marked swellings at their tips. In the presence of borax they were long and coiled like a cork-screw with many bulbous tips (Fig. 2).

Many callose plugs developed in pollen tubes of about 500-1000  $\mu$  or more in length, in most of the culture media including the control. The first plug was usually formed at about 200-500  $\mu$  from the grain end and usually 3-5 plugs appeared in each tube, at more or less regular intervals of 200-300  $\mu$ . Callose deposition may occur as a ring of thickening on the wall of the pollen tube, or may start from one side of the tube and then extend to the other side (Fig. 4. a-c). In either case as callose

TABLE I  
Percentage germination and pollen tube length  
in optimum concentrations of media, after  
24 hours at room temperature

Media	Optimum concentration	Germination %	Average tube length $\mu$
Distilled water	.. ..	45	510
Stigmatic extract	.. 2 stigmas/c.c. distilled water	20	60
Sucrose	.. 5%	72	1280
Borax	.. 10.0 mg./L	75	1690
2, 4 D	.. 0.001 "	80	4340
2, 4, 5-TPA	.. 0.001 "	65	1680
IAA	.. 0.1 "	65	1150
IPA	.. 10.0 "	72	1750
IRA	.. 0.001 "	42	1450
NAA	.. 0.01 "	65	1990
Kinetin	.. 0.01 "	61	1530
G.A.	.. 10.0 "	56	1340



FIGS. 1-5. Figs. 1-3. Pollen-tube formation in  $H_2O$ -borax (10 mg./L) and 2,4-D media (0.001 mg./L) respectively,  $\times 115$ ,  $\times 34$ ,  $\times 100$ . Figs. 4-5. Pollen tubes with prominent callose plugs,  $\times 263$ , a, b, c, d indicate the position and developmental stages of these plugs. (Borax-Sodium tetraborate; 2, 4-D 2, 4 Dichlorophenoxy acetic acid; 2, 4, 5-TPA-2, 4, 5-Trichlorophenoxy acetic acid; IAA—Indole 3-acetic acid; IPA—Indole 3-propionic acid; IBA—Indole butyric acid; NAA—Naphthyl acetic acid; G.A.—Gibberellic acid.)

accumulates, the passage becomes narrower and eventually it is completely closed (Fig. 5, c, d). Further deposition of callose results in the longitudinal extension of the plug. After the formation of the first plug, the distal portion of the pollen tube becomes cut off from the grain and from the older portion of the tube where elongation has ceased and the cytoplasm in it is non-nucleated and free from reserve food material. Successive plugs were also formed in this latter region. Some pollen tubes were also plugged just at the junction with the grain. Occurrence of callose plugs are reported in pollen tubes of many diversified taxa, both in culture and natural conditions.

They also seem to play an important role in the intermittent growth and elongation of pollen tubes.<sup>9,10</sup>

1. Johri, B. M. and Vasil, I. K., *Bot. Rev.*, 1961, **27**, 325.
2. Visser, T., *Meded. Landb-Hooges. (Wageningen)*, 1955, **55**, 1.
3. Kainberg, A. L., *Planta*, 1950, **38**, 377.
4. Baruah, H. K. and Raghavan, V., In *Modern Developments in Pl. Physiol.*, Ed. Maheshwari, P., Delhi Univ., 1958, p. 115.
5. Konar, R. N., *Curr. Sci.*, 1958, **27**, 216.
6. Vasil I. K., *Amer. J. Bot.*, 1960, **47**, 239.
7. Traub, H. P. et al., *Amer. Hor. Sci.*, 1936, **34**, 18.
8. Cooper, W. C., *Bot. Gaz.*, 1939, **100**, 844.
9. Brink, R. A., *Amer. J. Bot.*, 1924, **11**, 417.
10. Currier, H. B., *Ibid.*, 1957, **44**, 478.

## LETTERS TO THE EDITOR

### INCOHERENT SCATTERING OF GAMMA-RAYS IN ZIRCONIUM

THE influence of electron binding on the incoherent scattering of photons by atomic electrons is usually described by the well-known incoherent scattering function which is computed according to various models of atomic charge distributions depending upon the region of  $Z$ . Brown<sup>1</sup> has pointed out that for  $3 < Z < 28$ , the Hartree-Fock, for  $28 < Z < 50$  the Thomas-Fermi and for  $Z > 50$  the Dirac-Slater models are best suited. In the present investigations a typical element Zirconium ( $Z = 40$ ) is selected to test the accuracy of Thomas-Fermi calculations reported by Brown.<sup>1</sup> The 'subtraction technique' as employed before,<sup>2</sup> is used in the present work, utilising the recently reported more accurate theoretical photoelectric<sup>3</sup> and coherent scattering cross-sections.<sup>4</sup>

The total gamma-ray cross-sections in Zr are measured utilizing a modified narrow beam geometry at gamma energies 84, 100, 129 and 145 keV employing the sources <sup>170</sup>Tm, <sup>153</sup>Gd, <sup>191</sup>Os, and <sup>141</sup>Ce supplied by The Atomic Energy Establishment, Trombay. The experimental bound electron scattering cross-sections are determined by subtracting the theoretical photoelectric<sup>3</sup> and coherent scattering cross-sections<sup>4</sup> from the measured total gamma-ray cross-sections. The ratios of these cross-sections to the free electron scattering cross-sections are taken as a measure of the effect of electron binding on the incoherent scattering of gamma-rays. The same ratios are also determined, for comparison with the experimental values, utilising the theoretical incoherent scattering cross-sections based on Thomas-Fermi model reported by Brown<sup>2</sup> and the free electron scattering cross-sections. The results are given in Table I. It can be seen that the Thomas-Fermi model underestimates the effect of electron binding on the incoherent scattering cross-sections of gamma-rays in the energy region studied.

The authors are thankful to Prof. V. Lakshminarayana for his interest in this work.

TABLE I

Ratios of bound to free electron scattering cross-sections in Zirconium

Energy in keV	Experimental ratio	Theoretical ratio
84	$0.52 \pm 0.14$	$0.89 \pm 0.01$
100	$0.60 \pm 0.10$	$0.92 \pm 0.01$
129	$0.74 \pm 0.08$	$0.95 \pm 0.01$
145	$0.82 \pm 0.04$	$0.96 \pm 0.01$

The Labs. for Nuclear Research,  
Andhra Univ., Waltair,  
September 5, 1968.

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1. Brown, W. D., *Boeing Co. Report*, D2-125137-1, 1966.
2. Ramana Rao, P. V., Rama Rao, J. and Lakshminarayana, V., *Proc. Phys. Soc. (Lond.)*, 1965, **85**, 1081.
3. Schmickley, R. D. and Pratt, R. H., *Phys. Rev.*, 1967, **164**, 104.
4. Brown, W. D., *Boeing Co. Report*, D2-125136-1, 1966.
5. Lakshminarayana, V. and Swami Jnanananda, *Proc. Phys. Soc. (Lond.)*, 1961, **77**, 592.

### ONE CARRIER SPACE-CHARGE LIMITED CURRENTS IN GRADED P-N JUNCTIONS

AN extrinsic crystal like 'N' germanium when it is being diffused with trivalent impurities like boron or indium produces a  $p$ -type layer. The intermediate region between  $p$  and  $n$  regions is nearly intrinsic. A device so made can be treated as a  $p$ - $i$ - $n$  diode. The impurities in such an alloy diffused intrinsic layer can be assumed to have two approximated distributions (i) abrupt  $p$ - $n$  junction and (ii) a graded  $p$ - $n$  junction. In an unapproximated case they will have an exponential distribution. Here we will consider the problem in which the impurities are having a linear gradient. We will assume the current is entirely carried by minority carriers, i.e., holes. Diffusion current is ignored. There are no traps to bury the holes. Such a device in the case of abrupt junction was considered by O. J. Marsh and C. R. Viswanathan.<sup>1</sup> H. Y.

Fan<sup>2</sup> and S. M. Skinner<sup>3</sup> solved the general case when the diffusion term also is included. The above authors considered the solutions to forward biased *p-i-n* junction for intermediate currents.

In the present case the potential  $\phi$  at a point  $x$  in the barrier for large reverse currents can be obtained as

$$\phi = \left[ \frac{1}{g} \log \{ \sqrt{v} \zeta_{1/3}(w) \} \right] + \frac{a}{6} x^3 + vx + \text{constant} \quad (1)$$

where

$$v = E_1 - \frac{a}{2} x^2$$

$$g = \frac{a}{2b}$$

$$e = \sqrt{\frac{a}{2b^2}}$$

$$w = \frac{2}{3} ev^{3/2}$$

$$\left. \begin{aligned} a &= \frac{q(N_D^+ - N_A^-)}{e\lambda} \\ &= 7.5 \times 10^{15} \\ b &= \frac{i}{\mu_p \epsilon} \\ &= 3.923 \times 10^{17} \text{ I} \end{aligned} \right\} \text{ in M.K.S. units}$$

$$\zeta_{1/3}(w) = [A J_{+1/3}(w) + B J_{-1/3}(w)]$$

where  $J$ 's are the usual Bessel functions.

$E_1$  is the reverse field at a point  $x$  in the presence of a reverse current density  $j$  or current strength  $I$

$N_D^+$ ,  $N_A^-$  ionized donors and acceptors respectively.

$\lambda$  = width of the barrier =  $12 \mu$

$q$  = electronic charge

$\epsilon$  = dielectric constant

$\mu_p$  = hole mobility.

The current voltage characteristic with the following boundary conditions namely  $x = 0.2 \mu$ ,  $E_1 = 0$ ,  $\phi = 0$  and with constants  $A = 0.111$  and  $B = 1$  is drawn as shown in Fig. 1. This predicts  $I \propto V^{2.6}$  formula

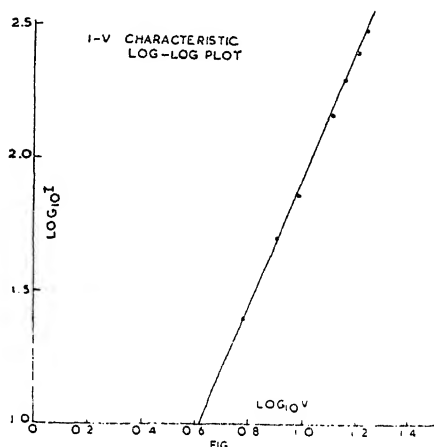


FIG. 1

which is the most valid law for the explanation of the behaviour of reverse characteristics of long germanium diodes.

Dept. of Physics, B. S. V. GOPALAM.  
Indian Institute of J. MAJHI.  
Technology,  
Madras, September 25, 1968.

1. Marsh, O. J. and Viswanathan, C. R., *J. Appl. Phys.*, 1967, 38, 3135.
2. Fan, H. Y., *Phys. Rev.*, 1948, 74, 1505.
3. Skinner, S. M., *J. Appl. Phys.*, 1955, 26, 509.

#### IS THE LOW-LEVEL INVERSION OVER NORTH-WEST INDIA AND WEST PAKISTAN DURING THE MONSOON SEASON DUE TO AIR-MASSSES OR DUE TO SUBSIDENCE?

In a recent paper Flohn *et al.*<sup>1</sup> have stated that vertical section taken from 0.6, 1.5 and 2.1 km. charts of vertical velocity showed an increase in subsidence with height in the layer 0.6 to 2.1 km. over the desert area. According to Fig. 5 of Das<sup>2</sup> there is descending motion at 900 mb along the western periphery of the Himalayas and about 400 km. further west. The following would, however, appear against their conclusions:

(a) According to Fig. 7 of Ramage<sup>3</sup> there is ascending motion of air below about 750 mb. over the area between about Lat. 23 and 26° N. and Long. 68 and 71° E., i.e., over the Thar desert and neighbourhood and descending motion above that level.

(b) Miller and Keshavamurthy<sup>4</sup> have, on the basis of computed vertical velocity, shown convergence over the West Pakistan heat-low

area in the layer surface to 900 m. (Fig. 3 A of their paper) and divergence south of Kathiawar.

(c) Computations of divergence by Bellamy<sup>5</sup> over the eastern portion of the West Pakistan heat-low indicated net ascent below 700 mb. and net descent above that level.

The inversion over Karachi is between 1.0 and 2.0 km. (Fig. 4 of Ramage) and not from the surface or above 3.0 km. This fact of observation cannot be reconciled either with the ideas put forward by Flohn *et al.* on the one hand and Ramage and Miller and Keshavamurthy on the other.

In his latest paper Desai<sup>6</sup> has discussed causes of aridity and inversion over the desert area and neighbourhood with reference to the views of Flohn<sup>7,8</sup> and Ramage and shown that their subsidence ideas do not support each other. The above discussion would also show that workers who have put forward subsidence ideas do not mean the same thing, some considering ascending motion while others descending motion in the lower levels over the desert area and neighbourhood. Thus the air-mass ideas<sup>9-11</sup> to explain the low-level inversion and little precipitation over and near the desert area are valid even now, and they explain more satisfactorily most of the facts of observations than the subsidence ideas put forward in recent years.

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September 9, 1968.

1. Flohn, H. *et al.*, *J. Atmos. Sci.*, 1968, **25**, 527.
2. Das, P. K., *Tellus*, 1962, **14**, 219.
3. Ramage, C. S., *J. Atmos. Sci.*, 1966, **23**, 144.
4. Miller, F. R. and Keshavamurthy, R. N., *International Indian Ocean Expedition, Mt. Monr.*, 1967, **1**, 1.
5. Bellamy, J. C., *Bull. Amer. Meteor. Soc.*, 1949, **30**, 45.
6. Desai, B. N., *Proc. Ind. Acad. Sci.*, 1968, **68A**, 103.
7. Flohn, H., *W.M.O. Tech. Note*, 1965, **67**, 245.
8. —, *Ind. J. Meteor. Geophys.*, 1966, **17**, 578.
9. Desai B. N., *Ibid.*, 1966, **17**, 399.
10. —, *J. Atmos. Sci.*, 1967, **24**, 216.
11. —, *Proc. Ind. Acad. Sci.*, 1967, **66A**, 306.

#### THIN LAYER CHROMATOGRAPHIC METHOD FOR THE SEPARATION OF METAL IONS—SEPARATION AS PAN COMPLEXES

A LARGE number of metal ions are known to form coloured chelates with the dye 1-(2-pyridyl azo)2-naphthol (PAN) and these are easily extractable in organic solvents like amyl alcohol, carbon tetrachloride, etc.<sup>1</sup>

In this laboratory<sup>2</sup> separation of large number of groups of ions has been carried out by thin layer chromatographic technique after suitably complexing these. It was the purpose of the present investigation to see if some of the metal ions investigated earlier can also be separated as PAN complexes, on a thin layer chromatogram.

Metal-PAN complexes of copper, cobalt and nickel were prepared separately by mixing solutions of the respective metal ions with 3-4 times of molecular proportions of an alcoholic solution of PAN. Immediate precipitate or coloration was formed. The same was extracted with chloroform and a 0.1% solution with respect to metal ion concentration prepared.

One drop each of the solutions was applied separately on the base line of glass plate coated with silica gel and the chromatogram developed using different eluents. Most compact spots with well-separated  $R_f$  values were obtained with an eluent consisting of a mixture of carbon tetrachloride(75)-methyl alcohol (25). The complexes being coloured, the metal spots could easily be located and identified.

A typical chromatogram showing the position of copper, cobalt and nickel and spots using the above-mentioned eluent and their separation from a mixture is reproduced in Fig. 1.

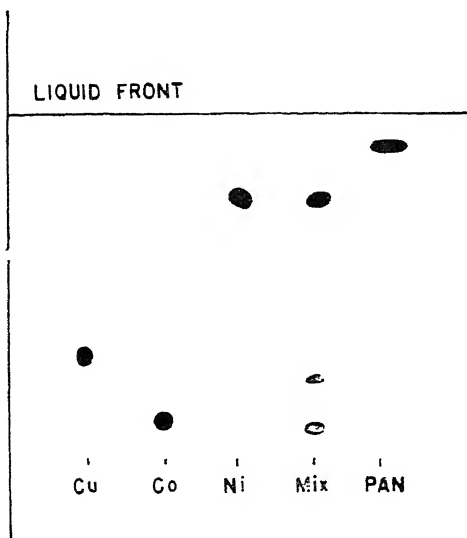


FIG. 1. Thin Layer Chromatography of Copper, Cobalt and Nickel as PAN Complexes.

The author is thankful to Shri M. R. Verma, Materials Analysis Division, for his keen interest and providing the necessary facilities.

National Physical Laboratory,  
New Delhi-12, November 1, 1968.

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1. Cheng, K. L. and Bray, R. H., *Analyt. Chem.*, 1955, 27, 782.
2. Verma, M. R., Gupta, P. K. and Rai, J., *Res. & Industry*, 1967, 12, 233.

### STUDIES ON THE MOLYBDENUM (VI)- KOJIC ACID COMPLEX

Kojic acid is found to give a yellow complex with molybdenum (VI) in aqueous solutions, the colour intensity being maximum in a medium of 6 N hydrochloric acid. The yellow product can be extracted into immiscible alcohols. 60% cyclohexanol in benzene (V/V) is found to be the best solvent for this complex. The complex is somewhat dissociative and maximum yellow colour is obtained only when the reagent concentration is 80-fold or more. The colour in both the aqueous and organic phases is quite stable showing no change even after 6 hours. A single extraction with 60% cyclohexanol in benzene recovers only 60% of molybdenum and quantitative recovery is realized with repeated extractions (3 times). The absorption spectra of the complex both in the aqueous phase and organic extract shows maximum absorbance at 365-370 m $\mu$ . The molar absorptivities of the complex in the aqueous and in the organic phases are 580 and 1250 respectively. Spectrophotometric evidence shows that both in aqueous and non-aqueous phases the complex has molybdenum and kojic acid in 1:1 ratio. In the alcoholic medium the solvation number is found to be 2. In view of the low molar absorptivities it is considered that the formation of the molybdenum (VI) kojate complex cannot be a satisfactory basis for the determination of molybdenum.

One of us (K. V. R.) thanks the Council of Scientific and Industrial Research for the award of the Research Fellowship.

Chemistry Department, V. PANDU RANGA RAO.  
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Waltair, October 29, 1968.

### X-RAY MEASUREMENT OF STACKING- FAULT PARAMETER IN AN AUSTENITIC Cr-Mn-N STAINLESS STEEL

We have undertaken an extensive investigation on the mechanical behaviour of austenitic stainless steels containing chromium, manganese and nitrogen. These steels have a stable face-centred cubic structure which confers on them the desirable properties of ductility and corrosion resistance. This material has been developed by the National Metallurgical Laboratory, India, in their programme to find a substitute for the widely-used Cr-Ni austenitic stainless steel, in view of the total absence of nickel resources in this country. Extensive investigations at the National Metallurgical Laboratory<sup>1</sup> and elsewhere<sup>2</sup> have shown that the Cr-Mn-N stainless steels compare well with the Cr-Ni stainless steels in such properties as corrosion resistance, strength and ductility characteristics, and weldability, etc., and, in certain instances such as resistance to atmospheres containing sulphur, are even superior.

The present note relates to the measurement of stacking-fault parameter in the substitute stainless steel by the Paterson<sup>3</sup> method, based on displacements of peak positions in the X-ray powder pattern. Stacking-fault energy, defined as the energy per unit faulted area, is known to have an important role in the deformation of metals and alloys.<sup>4</sup> Fault parameter ( $\alpha$ ), as determined by the X-ray powder method, gives the fraction of close packed (111) planes that are faulted and is inversely related to stacking-fault energy.<sup>5</sup> Measurements of fault parameter in face-centred cubic metals and alloys have led to very useful correlations with mechanical properties.<sup>6</sup>

The composition of the steel used in the present work is shown in Table I. The material was cold-worked by filing at room temperature. It was observed that the filings, which represent a drastic state of deformation, were non-magnetic, thus indicating the stability of the austenitic phase. Some of the filings were annealed at 1050°C. for one hour and then air-cooled to room temperature. A General Electric XRD-6 diffractometer equipped with a pulse-height analyser was used to obtain the intensity profiles. The filings were packed into the diffractometer specimen holder and held in position by a spray adhesive. Filtered Mo K $\alpha$  radiation was used and the intensity profiles of (111) and (200) reflections of the

annealed as well as cold-worked powders were continuously recorded using a goniometer speed of 0.2°/minute.

TABLE I

Composition of the substitute stainless steel

Element	Cr	Mn	N	C	P	S	Fe
Wt. %	21.79	18.25	0.75	0.065	0.027	0.12	Rest

The fault parameter ( $\alpha$ ) was calculated using the equation<sup>7</sup>

$$\Delta(2\theta_{200} - 2\theta_{111}) = \frac{-45}{\pi^2} \sqrt{3} \alpha (\tan\theta_{200} + \frac{1}{2}\tan\theta_{111})$$

where  $\theta_{200}$  and  $\theta_{111}$  are the Bragg angles and  $\Delta(2\theta_{200} - 2\theta_{111})$  represents the change in separation of 111 and 200 peak positions in the cold-worked state from the annealed state. For this purpose, the peak positions of the recorded profiles were determined by the Anantharaman<sup>8</sup> method as also the method suggested by Bolling *et al.*<sup>9</sup> An average value of 0.03 for  $\alpha$  was thus obtained. This is double the value of  $\alpha$  (0.015) reported by Goldman and Wagner<sup>10</sup> for austenitic 16Cr-12Ni steel.

The high value of  $\alpha$  in the Cr-Mn-N stainless steel should lead one to expect<sup>11</sup> that, during deformation, this steel would work-harden more rapidly than the Cr-Ni stainless steel. This was, in fact, found to be true when the change in hardness after cold-rolling the substitute stainless steel and an 18Cr-8Ni steel to various percentage reductions in thickness was measured (Table II).

TABLE II

Variation of hardness with cold deformation in Cr-Mn-N and Cr-Ni stainless steels

Percentage reduction in thickness	Diamond pyramid hardness number	
	Cr-Mn-N steel	Cr-Ni steel
0	270	160
10	350	225
20	410	280
30	465	330
40	495	355
50	520	375

It is now proposed to determine the variation of  $\alpha$  as a function of temperature of deformation as also composition in a range of Cr-Mn-N stainless steels.

We are thankful to the National Metallurgical Laboratory, Jamshedpur, for the supply of the steel used in this investigation. We also

thank Professor T. R. Anantharaman for facilities and encouragement.

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Varanasi-5, September 2, 1968.

1. Nijhawan, B. R. *et al.*, *J.I.S.I.*, 1967, 205, 294.
2. Zackay, V. F., Carlson, J. F. and Jackson, P. L., *Trans. A.S.M.*, 1956, 48, 509.
3. Paterson, M. S., *J. Appl. Phys.*, 1952, 23, 805.
4. Seeger, A., *Dislocations and Mechanical Properties of Crystals*, Ed. Fisher, J. C. *et al.*, John Wiley, New York, 1957.
5. Otte, H. M., *J. Appl. Phys.*, 1967, 38, 217.
6. Christian, J. W. and Swann, P. R., *Alloying Behaviour and Effects in Concentrated Solid Solutions*, Ed. Massalski, T. B., Gordon and Breach, New York, 1965, p. 105.
7. Warren, B. E., *Progr. Met. Phys.*, 1959, 8, 147.
8. Anantharaman, T. R. and Christian, J. W., *Brit. J. Appl. Phys.*, 1953, 4, 155.
9. Bolling, G. F., Massalski, T. B. and McHargue, C. J., *Phil. Mag.*, 1961, 6, 491.
10. Goldman, A. J. and Wagner, C. N. J., *Acta Met.*, 1963, 11, 405.
11. McLean, D., *Mechanical Properties of Metals*, John Wiley, New York, 1962.

#### DIFFERENCE IN INCIDENCE AND SEVERITY OF PYORRHEA IN MICE FED DIFFERENT DIETS

GREULICH AND ERSHOFF (1961) reported the appearance of periodontal lesions in X-irradiated mice at 100 days following the first exposure to multiple sublethal dose of total body X-irradiation, fed a purified diet. The animals fed on a stock diet, which were also X-irradiated, did not show any periodontal lesions. Periodontal changes following multiple sublethal doses of X-irradiation in mice have also been reported by Shapiro *et al.* (1960). The present studies were therefore initiated to find out if there were differences in incidences of pathological conditions in non-irradiated mice, fed purified and stock diets.

480 male mice of the Swiss Webster Strain were selected at 11 to 14 gm. in body weight and were divided into four comparable groups of 120 animals each. Two of these groups were fed a highly purified diet complete in all nutrients (Cerelease 59%; Vitamin-free Test Casein\* 24%; Cottonseed oil 10%; Wesson Modification of the Osborne-Mendel Salt Mixture,† 5%; Cellulose 2%; and the following vitamins per kg. of diet: thiamine hydrochloride, 10 mg.; calcium pantothenate, 60 mg.;

riboflavin, 10 mg.; pyridoxine hydrochloride, 10 mg.; nicotinic acid, 100 mg.; ascorbic acid, 200 mg.; biotin, 4 mg.; folic acid, 10 mg.; para-aminobenzoic acid, 400 mg.; inositol, 800 mg.; Vitamin B<sub>12</sub>, 150 µg.; 2-methyl-1,4-naphthoquinone, 5 mg.; choline chloride, 2 gm.; Vitamin A, 5,000 units; Vitamin D<sub>2</sub>, 500 U.S.P. units; and alphatocopherol acetate, 100 mg. The vitamins were added in place of an equal amount of cerelose. The remaining two groups were fed a natural food stock ration (Wayne Lab-Blox in meal form).

Six animals were selected at random and sacrificed from each of the two dietary groups after 120, 240 and 360 days. The heads were placed in 10% neutral formaldehyde solution for fixation, decalcified in 10% nitric acid and 10% formaldehyde, washed with saturated lithium carbonate, dehydrated, and then sectioned at 7 microns and stained with hematoxylin and eosin.

Microscopic examination of the histological sections revealed the following findings:

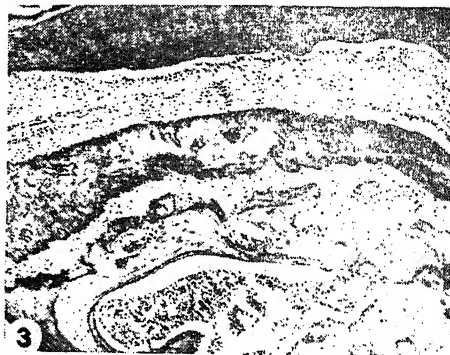
The Swiss Webster Strain-120 series, fed the purified diet, had well developed and normal appearing teeth, supported by a normal periodontal membrane and normal alveolar bone (Fig. 1), whereas the mice fed on the stock

which were supported by poorly developed convoluted and irregularly calcified alveolar bone (Figs. 2 and 3), resulting in moderate occurrence of pyorrhea. The poorly developed teeth and bone of these animals attest to the nutritional inadequacy of this ration, for mice of the Swiss Webster Strain. These results were consistent, however, in the mice sacrificed after 340 days.



FIG. 1. Molar of mouse of the Swiss Webster Strain fed the purified diet. Note the normal appearing tooth supported by well-developed periodontium and alveolar bone,  $\times 72$ .

diet exhibited poorly developed teeth with thin and occasionally degenerated dentin,



FIGS. 2-3. Fig. 2. Molar of mouse of the Swiss Webster Strain fed the stock diet. Note poorly developed dentin and acellular cementum,  $\times 72$ . Fig. 3. Molar of mouse of the Swiss Webster Strain fed the stock diet. Note degenerated dentin and acellular cementum,  $\times 72$ .

The observations made in the present studies, where multiple sublethal doses of total body X-irradiation were not given but the animals were fed with purified and stock diets, reveal the fact that X-irradiation factor in the earlier studies by Greulich and Ershoff (1961) were responsible for certain pathological conditions in the animals fed purified diet after 100 days. On the other hand, the X-irradiation of animals fed on stock diet did not cause any periodontal abnormality (Greulich and Ershoff).



However, as shown in the present studies, non-irradiation of animals fed on stock diet caused most of the pathological symptoms of teeth, including a moderate occurrence of pyorrhea.

I am very grateful to Dr. Benjamin H. Ershoff for his valuable help in carrying out this project in his laboratories at Culver City, California. My thanks are also due to Miss Anne Hutton for rendering help in the preparation of this paper.

Loyola of Montreal, K. S. DEINDSA.  
Montreal, Canada,  
August 20, 1968.

\* Vitamin-free Test Casein, General Biochemicals, Inc., Chagrin Falls, Ohio.

† Wesson Modification of Osborne-Mendel Salt Mixture, General Biochemicals, Inc., Chagrin Falls Ohio.

1. Greulich, R. C. and Ershoff, B. H., *J. Dent. Res.*, 1961, 40, 1211.
2. Shapiro, M., Brat, V. and Ershoff, B. H., *Ibid.*, 1960, 39, 668.
3. Federov, N. A. and Prokhonchukov, A. A., *Stomatologia*, Moscow, 1959, 2, 3.
4. Baer, P. N. and Berneck, S., *Oral Surg., Oral Med. & Oral Path.*, 1957, 10, 430.
5. King, J. D. and Gimson, A. P., *Brit. J. Nutr.*, 1948, 2, 111.
6. Gupta, O. P. and Shaw, J. H., *Oral Surg., Oral Med. & Oral Path.*, 1956, 9, 592.

#### THERMOGRAVIMETRIC ANALYSIS (TGA) OF ARSENIC (III, V) SULPHIDES PRECIPITATED WITH POTASSIUM THIOCARBONATE

In earlier publications from these laboratories, TGA of solid potassium thiocarbonate<sup>1</sup> ( $K_2CS_3$ ) and thallos thiocarbonate<sup>2</sup> ( $Tl_2CS_3$ ) precipitated with PTC have been reported. A survey of literature reveals that there is some degree of uncertainty with regard to the composition of the sulphides of arsenic (III, V) as obtained by precipitation from acidic media. In the present communication, therefore, work on TGA of arsenic (III, V) sulphides precipitated with PTC from acidic medium have been carried out with a view to establish the stoichiometry of the precipitated products and their mode of transformation with rise in temperature. The thermogravimetric data were collected using a Stanton's Thermorecording Balance model TR-I and the procedure followed was the same as given in earlier publications.<sup>1,2</sup>

**Precipitation of Arsenic (III, V) Sulphides.**—Aqueous solutions of sodium arsenite and arsenate containing about 50 mg. of As (III, V) per 100 ml. were made acidic with hydrochloric acid so as the solutions were 1N with

respect to hydrochloric acid. An aqueous solution of PTC (0.2M) reagent was added dropwise with stirring till the precipitation was complete. The precipitates were digested on a hot water-bath for half-an-hour and then collected by filtration through Whatman filter-paper No. 42. The precipitates after washing with water and then with alcohol were dried at room temperature by keeping in a vacuum desiccator for about 36 hours.

**Thermogravimetric Behaviour of  $As_2S_3$ .**—Thermogram of arsenic trisulphide is given in Fig. 1, A. All the samples of arsenic

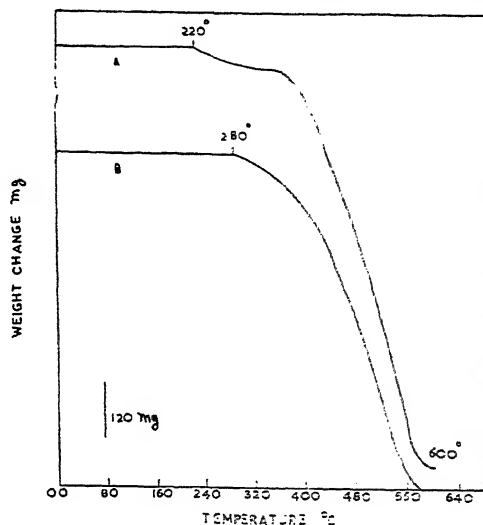


FIG. 1. Thermal Decomposition of  $As_2S_3$  (A) and  $As_2S_5$  (B).

trisulphide obtained under similar conditions gave a horizontal level upto 220° showing the purity (free from sulphur) and the stability of the sulphide upto 220°. Beyond this temperature, it sublimed and was superficially oxidised. The crucible was completely empty by the time the temperature had reached 600° except for a trace of residue which did not change in weight. The observations tally with the TGA studied of  $As_2S_3$  precipitated with hydrogen sulphide, as carried out by Duval,<sup>3</sup> thus establishing the purity of  $As_2S_3$  precipitated with PTC.

**Thermogravimetric Behaviour of  $As_2S_5$ .**—The sample of arsenic pentasulphide gave a horizontal level upto 280° showing the absence of free sulphur and stability of the sulphide upto 280°. Beyond this temperature, it sublimed and was superficially oxidised. The crucible was completely empty by the time

the temperature had reached 580° (Fig. 1, B). Taimni and Tandon<sup>4</sup> reported that  $As_2S_5$  precipitated with sodium sulphide remains stable upto 270°, and crucible gets empty at 550°.

Duval<sup>3</sup> who studied the thermal behaviour of a sample of  $As_2S_5$  precipitated by hydrogen sulphide had found that it yields a horizontal extending from 78° to 245° and the sulphide sublimes beyond this temperature. Yosida<sup>3</sup> reported that a precipitate of  $As_2S_5$  should not be dried above 130° as it starts decomposing above this temperature. We feel that it was due to the presence of free sulphur in the product studied by him. The initial loss in weight before 78°, as indicated by Duval, may be due to the presence of adherent water.

We are grateful to Emeritus Prof. T. R. Seshadri, F.R.S., for his keen interest, to the Director, Central Road Research Institute, New Delhi, for allowing the use of Thermorecording Balance installed in the Institute and to the Council of Scientific and Industrial Research, New Delhi, for the award of a Fellowship to one of us (N. K. K.).

Department of Chemistry, K. N. JOHRI.  
University of Delhi, N. K. KAUSHIK.  
Delhi-7, September 17, 1968. KIRPAL SINGH.

1. Johri, K. N., Kaushik, N. K. and Singh, K., *Curr. Sci.*, 1967, **36**, 458.
2. —, — and —, *Ibid.*, 1967, **36**, 515.
3. Duval, C., *Inorganic Thermogravimetric Analysis*, Elsevier Publishing Co., Amsterdam, 1963, p. 426.
4. Taimni, I. K. and Tandon, S. N., *Anal. Chim. Acta*, 1960, **22**, 34.

#### KINETICS OF CESIUM-137 ISOTOPIC EXCHANGE BETWEEN VARIOUS SEAWEEDES AND SEA-WATER

DATA on isotope accumulation in marine algæ are of particular importance, both from the standpoint of algal physiology and inshore contamination by coastal reactors and nuclear explosions. A knowledge of the concentration, elimination and discrimination factors of the fission products, especially of Cs-137 by marine algal species, is essential from the radioecological point of view and no such work on Indian seaweeds is reported. In this communication, the kinetic and physico-chemical aspects of the Cs-137 uptake and elimination are considered quantitatively for several species of marine algæ.<sup>1</sup>

Freshly collected algal material (50 gm. each) from Veraval and Okha coasts, was washed with filtered sea-water and for each of the algal species to be studied, two sets of

containers were taken, one series (10-12 bowls) for exposure to fluorescent light (1,600 lux) and the other for keeping in dark. 50 ml. of filtered sea-water (from the same stock solution for use in all the experiments) was taken in the various containers and about 1 gm. of pure seaweed was added a few hours before the start of the experiment to allow the algæ to adjust to the new conditions. All the containers were aerated throughout the experiment and kept at constant temperature (30° C.). About 0.4-0.5  $\mu$ C of Cs-137 as CsCl in HCl (1,000 cpm/ml. of sea-water) was then homogeneously distributed in sea-water and the experiment started. The marked containers were removed after 0,  $\frac{1}{2}$ , 1, 2, 3, 4 and 6 days; the plant material was first washed with distilled water and blotted dry with tissue paper, weighed (wet weight) and then put in a pre-weighed petri dish for drying (48 hours) in an oven at 80° C. The dried sample, after weighing was ground to a coarse powder, transferred onto a planchet and counted in a single-channel  $\gamma$ -ray spectrometer [NaI(Tl) 1"  $\times$  1" crystal]. One ml. of sea-water was also taken on a planchet separately from the containers, evaporated to dryness under an I.R. lamp and counted for Cs-137 as above. In most cases, the radioactivity of sea-water does not change noticeably throughout the course of the experiment. The concentration factor ( $K_c$ , ratio of activity in one gram of fresh seaweed to that in one gram of sea-water medium) was calculated by adjusting the observed activities per one gram of seaweed (wet weight) and sea-water. The values of  $K_c$  thus obtained were plotted as a function of time of uptake (cf. Fig. 1). Similarly, the elimination factor ( $K_e$ , the ratio of the amount of radionuclide eliminated from the species into the environment per gram) was found out for each of the species at various times by calculation and their values were also plotted.

It is seen from Fig. 1 that Cs-137 is rapidly concentrated by marine algæ and that a steady state ( $K_s$ ) is reached within a period of a few days. All the three types of algæ studied showed a low concentration factor,  $K_s$ , varying between 2-8 and reaching equilibrium ( $t_s$ ) in 1-3 days. The red algæ have maximum uptake of Cs-137, the  $K_s$  and  $t_s$  values being 7.5 and 1.5 for *Gelidiella acerosa* and 5 and 2 respectively for *Gracilaria millardetii* followed by brown ( $K_s$  3.5, *Sargassum johnstoni*) and green ( $K_s$  2.9 *Ulva fasciata*) algæ. The low  $K_s$  values for Cs-137 are due to the much

greater abundance of potassium present in sea-water which has a similar biochemical and physiological character to cesium. Since the concentration of potassium in sea-water is

the uptake of Cs-137 is governed not by the cesium concentration alone but mainly by potassium. Thus, a two-fold enhancement of the concentration for Cs-137 was actually observed<sup>2</sup> when the potassium content in sea-water is reduced by half. Besides, it is evident that the values of  $K$  and  $\hat{K}$  in all the species studied coincided to a single  $K_s$  value at time  $t_s$  showing a characteristic isotopic exchange phenomenon<sup>3</sup> for Cs-137 between the algae and the environment.

A look at Fig. 1 also shows that the exchange of Cs-137 by various algae follows a logarithmic function and can be written as  $K = K_t + n \ln t$  where  $K_t$  is the isotope concentration in time  $t$ . The steady state concentration factor  $K_s$  can then be evaluated from an expression<sup>4</sup> of the type

$$K_s = \frac{\hat{n}K_t - n\hat{K}_t}{\hat{n} - n}$$

where  $K_t$  and  $\hat{K}_t$  are the isotope concentration and elimination factors in time  $t$  and  $n$  and  $\hat{n}$ , the coefficients characterising the rate of concentration and elimination respectively. The constant values  $n$  and  $\hat{n}$  in the above equation are calculated by the method of least squares for each of the algal species. If these functions are known, it is then possible to calculate and predict the  $K_s$  values from any two sets of  $K_t$  values experimentally obtained. Thus, a set of calculated values for each of the algal species studied with the experimental data are presented in Table I.

Thus, the use of the above formula with a knowledge of the concentration factor enables a number of measurements of radioactivity in the algae to be reduced to a minimum, besides enabling one with new formulations for rate of exchange of the element in the environment, etc.

Thanks of the authors are due to Dr. D. S. Datar for his keen interest and to Dr. P. S. Rao for valuable suggestions.

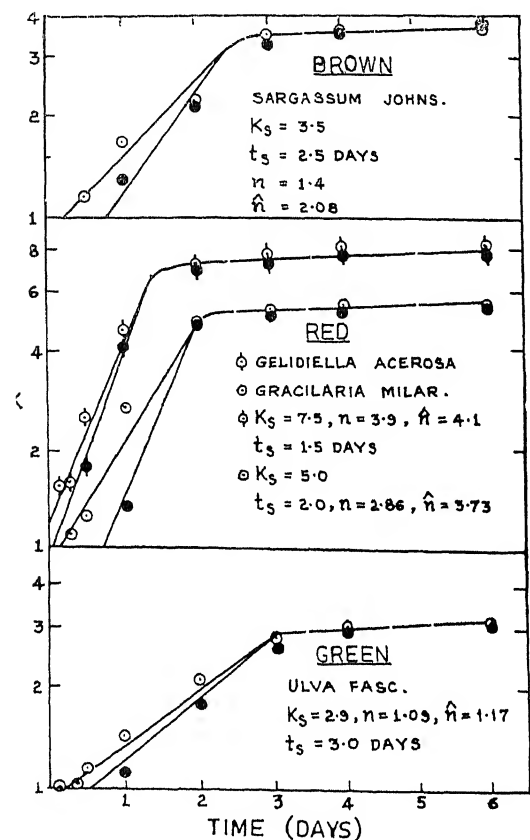


FIG. 1. Kinetics of cesium-137 isotopic exchange between seaweeds and sea-water (semi-logarithmic co-ordinates) ○ uptake of isotope ● elimination of isotope. The dashed line denotes a steady level of isotopic exchange.

380 mg./l and that of cesium around  $1 \mu\text{g./l.}$ , the raise of cesium content upto 1,000 times over the normal content even does not increase the  $K_s$  value, as the total amount of cesium and potassium in sea-water remains practically the same. It is thought, therefore, that

TABLE I

Algae		$K_t$ and $\hat{K}_t$ (from graph, exptl.)	$n$ and $\hat{n}$ (slopes)	$K_s$ from equation (predicted)	$K_s$ from graph (exptl.)
<i>Gelidiella acerosa</i>	..	2.25      2.00	3.90      4.10	7.13	7.50
<i>Gracilaria milardei</i>	..	2.10      1.50	2.86      3.73	4.10	5.00
<i>Sargassum johnstoni</i>	..	2.00      1.30	1.40      2.08	3.44	3.50
<i>Ulva fasciata</i>	..	1.60      1.50	1.09      1.17	2.99	2.90

Central Salt and Marine (MISS) J. M. PAREKH.  
Chemicals Res. Inst., S. T. TALREJA.  
Bhavnagar, Y. A. DOSHI.  
August 30, 1968.

1. Doshi, Y. A. *et al.*, *Proc. of Natl. Inst. of Sciences (India)*, Part B (In press).
2. Bryan, G. W., *J. Marine Biol. Assoc.*, U.K., 1961, 41, 551.
3. Polikarpov, G. G., *Radioecology of Aquatic Organisms*, North Holland Publ. Co., Amsterdam, 1966, p. 59.
4. Barinov, G. C., *Okeanologiya*, 1965, 5 (1), 111.

**METACERCARIA OF *GALACTOSOMUM*  
*PUFFINI* YAMAGUTI, 1941  
(TREMATODA: HETEROPHYIDAE)  
FROM MARINE FISHES OF WALTAIR  
COAST, BAY OF BENGAL**

TREMATODES of the genus *Galactosomum* are widely distributed in shore birds. Although no single life-cycle has yet been elucidated experimentally, information accumulated from isolated reports of various stages gives convincing evidence of the possible course of life-cycle in this genus. Presumably non-aggregating magnacercous cercariae of the opisthorchioid group develop into metacercariae in fishes and subsequently into adults of *Galactosomum* spp. in ichthyophagous birds.<sup>1-3</sup> There have been reports of adults and cercaria of *Galactosomum* spp. from India. Anantaraman<sup>4</sup> recorded four species of this genus from Madras, three of them from shore birds and one a juvenile in crabs. One species, *G. puffini* Yamaguti, 1941, occurs commonly in three species of sea-gulls of Waltair shore, namely, *Larus argentatus* Pontoppidan, *L. ridibundus* (Linnaeus) and *L. brunnicephalus* Jordon. What appears to be a probable cercaria of this genus has recently been described from *Turritella attenuata* Reeve, 1897, from Madras Coast.<sup>3</sup> The present communication deals with a metacercaria from marine fishes of Waltair Coast, Bay of Bengal.

Four species of clupeoid fishes, *Sardinella fimbriata* (Val.), *S. gibbosa* (Bleeker), *Stolephorus commersonii* Lacépède and *Dussumieria acuta* Val. were found to harbour metacercariae of *Galactosomum puffini*, the infection being heavy in sardines and they probably represent natural intermediate hosts. The metacercariae appearing as small white spots were found encysted on the oesophageal wall. The incidence of infection in sardines is high, almost every fish examined during September to March period has been found to be infected. Three to 10 cysts were encountered in each infected

host. The cysts are oval in shape measuring 0.51-0.56 mm. in length and 0.19-0.28 mm. in width. The cyst wall is tough and elastic. The metacercaria which lies folded inside the cyst has the following structure (Fig. 1). Measurements are in millimetres.

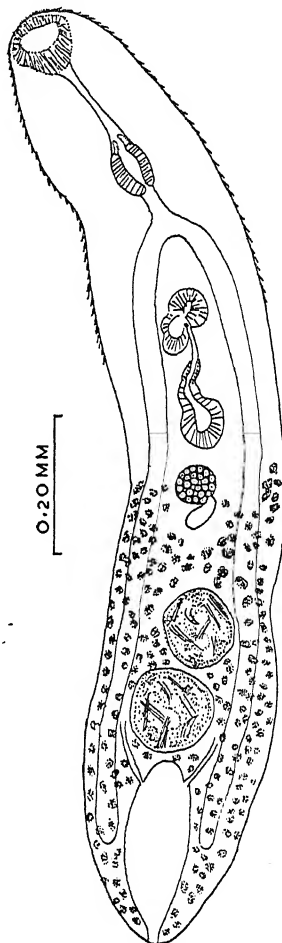


FIG. 1. Metacercaria of *Galactosomum puffini* from *Sardinella fimbriata*.

Body elongate, 1.04-1.76 long and 0.22-0.28 wide. Cuticle is densely spined in the anterior half of body. Oral sucker subterminal, 0.074-0.078 × 0.078-0.085 in size. Acetabulum small, 0.04-0.046 in diameter and enclosed in genital atrium. Prepharynx measures 0.11-0.156 in length. Pharynx cylindrical, 0.058-0.097 long and 0.05-0.07 wide. Oesophagus 0.019-0.039 long and bifurcates into two caeca which extend to posterior end of body. Several unicellular gland cells whose ducts lead into pharynx are seen in the space between

intestinal bifurcation and acetabulum. Testes oval,  $0.098-0.158 \times 0.097-0.156$  in size situated in tandem in the intercæcal area in the posterior third of body. Vesicula seminalis—post-acetabular, bipartite, thick-walled, the posterior part is globular and anterior part is cylindrical. A short pars prostatica leads into ductus ejaculatorius which in turn opens into genital atrium. The latter is spacious and encloses acetabulum. A small muscular gonotyl projects from genital atrium. Ovary entire, pre-testicular,  $0.046-0.07 \times 0.054-0.070$  in size. An empty receptaculum seminis is situated posterior to ovary. Immature vitelline follicles are distributed in the space between ovary and posterior end. Excretory vesicle tubular, terminating below the posterior testis.

The structure of the metacercaria is identical to that of *G. puffini* which as adult occurs in sea-gulls of this coast, the only notable difference is the shape of posterior part of seminal vesicle which is globular in the metacercaria and elongate in the adults from gulls. It is possible that seminal vesicle gets distended in the adult owing to accumulation of spermatozoa. Since only one species of *Galactosomum* occurs in gulls of this region, the identity of the metacercaria to *G. puffini* may be unequivocal. Both sardines and gulls abound in this area during September to March. The sardines form a favourite food of gulls. It is a beautiful sight to see that when shoals of sardines are being dragged ashore from shore seine operations by fishermen, the sea-gulls encircle the nets and feed voraciously on sardines.

Prudhoe<sup>5</sup> in a review on the genus *Galactosomum* cited studies indicating descriptions and records of metacercariæ in the genus. A partial account of the life-cycle has recently been given by Sogandares-Bernal and Hutton.<sup>2</sup> They described metacercaria of *G. spinetum* (Braun, 1901), in *Hyporhamphus unifasciatus* (Ransoni) at Florida and obtained metacercariæ of an unidentified species of *Galactosomum* experimentally in *Fundulus similis* (Baird and Girard) following exposure to magnacercous cercariæ developing in *Cerithium muscarum* Say. It can be seen that considerable information has accumulated on the larval stages and possible intermediate hosts of *Galactosomum* spp. Further experiments are needed to link the various life-history stages and to determine the cycle of hosts involved.

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us (R. M.) thanks the University Grants Commission for the award of a Fellowship.

Dept. of Zoology, R. MADHAVI.  
Andhra University, K. HANUMANTHA RAO.  
Waltair, August 12, 1968.

1. Cable, R. M., *Sci. Survey of Porto Rico and Virgin Islands*, 1976, **16**, 491.
2. Sogandares-Bernal, F. and Hutton, R. E., *Proc. Helminth. Soc. Wash.*, 1960, **27**, 75.
3. Reimer, L. W. and Anantaraman, S., *Curr. Sci.*, 1968, **37**, 316.
4. Anantaraman, S., *Jour. Mar. Biol. Assoc. India*, 1963, **5**, 137.
5. Prudhoe, S., *J. Helminth.*, 1949, **23**, 135.

#### ON THE OCCURRENCE OF *EUPHAUSIA DISTINGUENDA* HANSEN IN THE NORTH-WESTERN BAY OF BENGAL

THERE are no records of *Euphausia distinguenda* Hansen, north of  $7^{\circ} 01' N$  from the Bay of Bengal although it has been reported to be the dominant and characteristic species of euphausiids in the Indian Ocean.<sup>1-6</sup> Several specimens of this euphausiid were obtained from the gut contents of *Carangoides malabaricus* (Bloch and Schneider) collected from trawl catches from north-western parts of the Bay of Bengal, first on 18th July 1964, and again on 8th August 1966. The first sample of fishes was from a depth of 55 m. at the station  $18^{\circ} 35' N$ ,  $84^{\circ} 35' E$ , and the second from 46 to 49 m. at the station  $17^{\circ} 35' N$ ,  $83^{\circ} 25' E$ . In both cases the euphausiids were very fresh and showed no signs of having been even partially digested.

The present material shows all the characters of *E. distinguenda* as described by Hansen.<sup>7-8</sup> The length (from the tip of the rostrum to the tip of the telson) of the males varies from 7.5 to 12.5 mm. and that of the females from 8.0 to 13.5 mm.

All the specimens of *E. distinguenda* in the collection made on 8-8-1966 are adults while those on 18-7-1964 comprised both adults and sub-adults. Completely formed spermatophores are observed in the sperm sacs of males. The thelyca of females are invariably found with spermatophores attached. Sebastian<sup>6</sup> while giving drawings of a few stages in the development of thelycum of *E. distinguenda* has shown two spermatophores attached to it. Bargmann<sup>9</sup> describing the life-history of *E. superba* states that as a general rule, two spermatophores are found on each

female. He also reports the occurrence of 8 spermatophores which, in his opinion, may be presumably cases of multiple pairing. In the present material, 1 to 8 spermatophores, mostly 2, have been observed on the thelycum, some of them half empty. According to Bargmann,<sup>10</sup> "The spermatophores are expelled from the ejaculatory duct and are caught by the pleopods which transfer them into the thelycum. This operation must be a rapid one, for although male specimens have been obtained with spermatophores extruding from the genital pores, they have never been seen holding them in the pleopods". In one male specimen of *E. distinguenda* of the present material, it is seen that a single spermatophore is held by the processes of the modified endopod of the right side of the second pair of pleopods (Fig. 1). This observation gives support to the assumption that spermatophores are passed from the second to the first pair of pleopods which then fix them to the thelycum of the female.



FIG. 1. Spermatophore (indicated by arrow) held by the processes of the modified endopod of the second pleopod of right side in a male specimen of *E. distinguenda* Hansen.

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Central Marine Fisheries  
Res. Inst., Mandapam Camp,  
August 20, 1968.

S. REUBEN.\*

1. Illig, G., *Wiss. Ergebn. Deutsch Tief-See Exped., 'Valdivia'*, 1930, 22 (6), 400.
2. Torelli, B., *Mem. R. Comm. Talassogr. Ital.*, 1934, 208, 1.
3. Tattersall, W. M., *Sci. Rept.*, 1939, 5 (8), 203.
4. Brinton, E., *All-India Seminar on Marine Sciences*, Waltair, 1963, April 26-27, p. 1 (Mimeo).
5. Ponomareva, L. A., *Trud. Inst. Okeanol.*, 1964, 64, 265.
6. Sebastian M. J., *Symposium on Crustacea Part I*, Mar. biol. Ass. India, Mandapam Camp, 1963, p. 233.
7. Hansen, H. J., *Inst. Ocean. Monaco*, 1911, 210, 1.
8. —, *Mem. Mus. Com. Zool.*, Harvard College, 1912, 35 (4), 173.
9. Bargmann, H. E., *Discovery Report*, 1945, 23, 103.
10. —, *Ibid.*, 1937, 14, 325.

### ENDOSPERM IN *PSITTACANTHUS*

ABBIATTI (1946) AND RIZZINI (1960) reported that *Psittacanthus* (Loranthaceae) lacks an endosperm. On this account, Barlow (1964) classified it in the subtribe *Psittacanthinae* of the tribe *Loranthae*. However, he mentions that: "The distinction of subtribe *Psittacanthinae* on the absence of endosperm is probably not justified (MacBride, 1937), and the group is probably unnatural." Since *Psittacanthus* is one of the only two members of the *Loranthaceae* in which endosperm is reported to be absent, this aroused our curiosity and hence its embryology was investigated.

In *Psittacanthus cuneifolius* (Ruiz et Pav.) Blume, a semiparasite, occurring wild in Argentina, the flowers are nearly 45 cm. long and showy. They are hexamerous and bisexual borne singly in the axil of leaves. There are six stamens which are alternately long and short. Anthers are dithecous and versatile, and produce triradial, 2-celled pollen grains. The placenta is absent and sporogenous tissue differentiates directly at the base of the ovarian cavity. A prominent tubular hypostase is present. The fruit is baccate.

Several embryo sacs grow into the style, and endosperm develops in the lower part of the gametophytes contained in the ovary. Gradually endosperms of these embryo sacs fuse and form a composite structure. Although some of the endosperm tissue is absorbed by the developing embryo, a major portion persists in the mature fruit (Fig. 1, A-C). Even at the time of germination (Fig. 1, D), the embryo is surrounded by a massive endosperm. The embryo is dicotyledonous, and the radicular end is studded with numerous papillate outgrowths. Both endosperm and embryo contain abundant starch.

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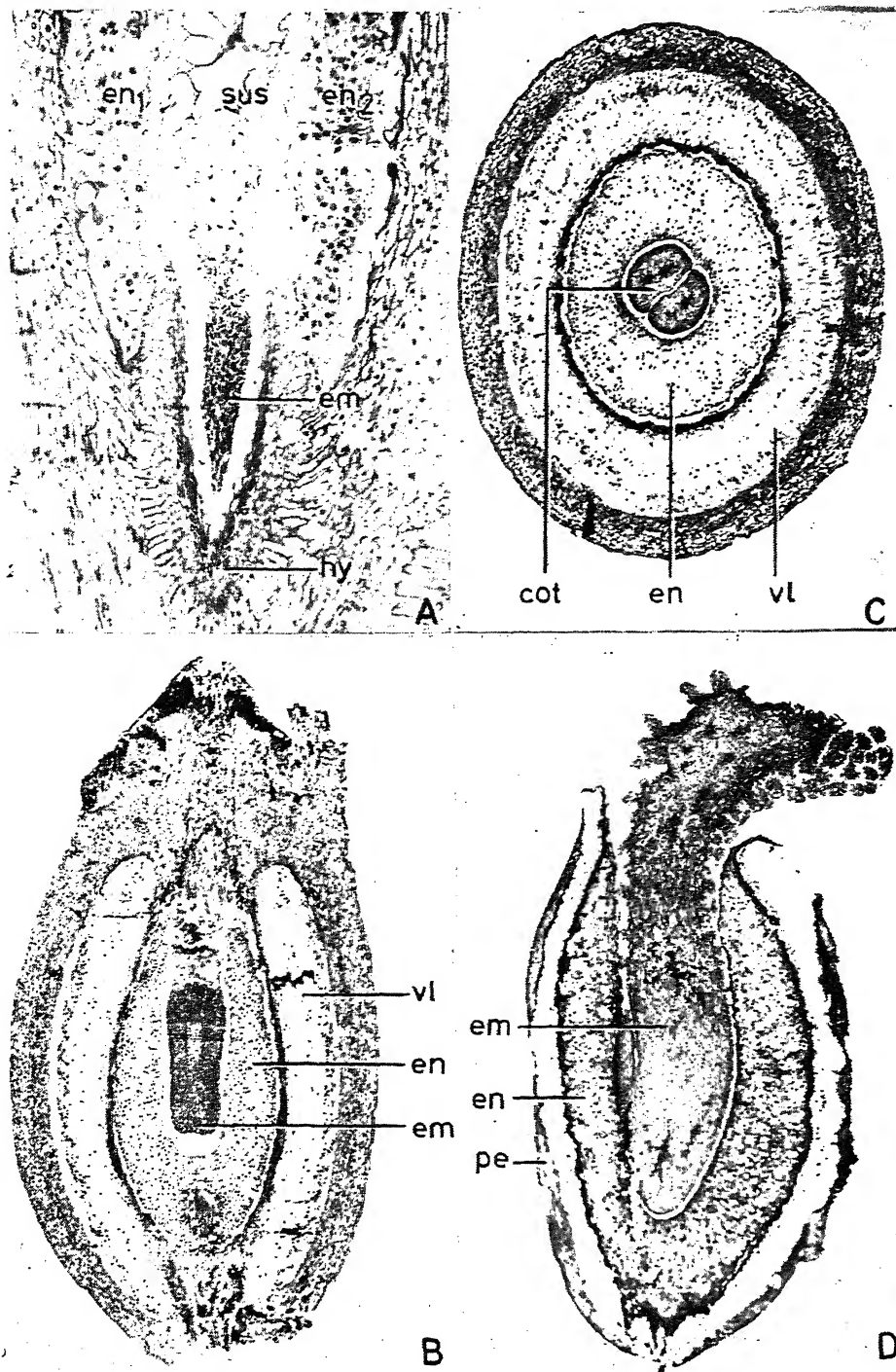


FIG. 1. A-D. A. L.S. young fruit with advanced stage of endosperm in two embryo sacs; the embryo shows a multi-riate suspensor,  $\times 73$ . B. L.S. near-mature fruit showing massive endosperm and embryo,  $\times 10$ . C. T.s. same; note the two cotyledons surrounded by composite endosperm,  $\times 10$ . D. L.S. mature fruit with germinated embryo; note the presence of endosperm,  $\times 11$ . (cot, cotyledon; em, embryo; en, endosperm; hy, hypostase; pe, pericarp; sus, suspensor; vl, viscid layer.)



The fruit wall comprises an outer fleshy zone, followed by a viscid zone of two layers, and a parenchymatous zone of 3-5 layers through which runs the vascular supply. There are abundant sclereids in the outermost zone.

Thus, as in the tribe Lorantheae, in *Psittacanthus* also the ovary is 1-celled, placenta is absent, embryo sacs ascend into the style, and fruit is baccate. Besides, the endosperm in this taxon develops like any other member of the Lorantheae. It is hardly justified, therefore, to create a separate subtribe *Psittacanthinae* for this genus.

We are grateful to the late Professor P. Maheshwari, F.R.S., and Professor B. M. Johri for their kind advice and encouragement, and to Professor A. T. Hunziker (Argentina) for providing the material.

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Delhi-7, September 3, 1968.

1. Abbiati, D., *Revta Mus. La Plata, Bot.*, 1946, 7, 1.
2. Barlow, B. A., *Proc. Linn. Soc. N. S.W.*, 1964, 89, 268.
3. Rizzini, C. T., *Ann. Mo. bot. Gart.*, 1960, 47, 263.

#### PARTICLE SHAPE OF SOUTHERN SANNHEMP MOSAIC VIRUS

SOUTHERN sannhemp mosaic virus has been reported to be a strain of tobacco mosaic virus (TMV) (Capoor, 1962). Also the virus has been shown to have serological relationship with TMV (Anand and Sahambi, 1965). Therefore, purification of this virus was attempted to get a clear picture of the nature of its particles. About 1,000 gm. of sannhemp (*Crotalaria juncea* L.) leaves infected with and showing most prominent symptoms of this virus disease were processed by the chemical method employed in the purification of Bottle-gourd mosaic virus (Anand, 1960), but with slight modification. The virus from the virus precipitate, during the treatment, was eluted by means of 1% sodium sulphite solution instead of distilled water. This helped in preventing the formation of colouring matter during elution of the virus from its precipitate, and thus only one treatment with ammonium sulphate was found sufficient. The virus was further concentrated by precipitating it at pH 4.3. The infectivity of the purified material was confirmed by sap inoculations on *Cyamopsis tetra-*

gonoloba L. Taub. which reacted with typical local lesions (Raychaudhuri, Nariani and Das, 1968). The electron micrographs taken with RCA-EMU 2-A electron microscope at the National Physical Laboratory, New Delhi, revealed the virus particles to be rigid rods resembling those of tobacco mosaic virus (Fig. 1). Das Gupta, De and Raychaudhuri

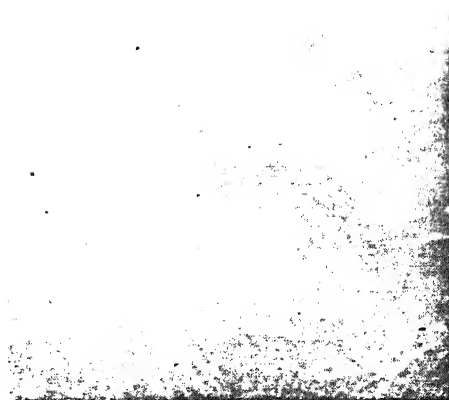


FIG. 1. Sannhemp mosaic virus.

(1961) observed that the other mosaic virus-infecting sannhemp in Delhi is spherical in shape measuring on an average 33 m $\mu$  in diameter, while Chenulu has purified a cowpea mosaic virus which infects sannhemp-producing mosaic symptoms, which is also spherical, measuring 19-25 m $\mu$  with an average of 23 m $\mu$  in diameter.

The author is thankful to Dr. S. P. Raychaudhuri for his keen interest and encouragement, to Dr. S. K. Sharma and Mr. G. L. Malhotra for taking the electron micrographs, and to Dr. H. S. Sahambi for his co-operation.

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Plant Pathology,

Indian Agric. Res. Inst.,

New Delhi, August 30, 1968.

1. Anand, G. P. S., *Indian Phytopathology*, 1960, 13, 55.
2. — and Sahambi, H. S., *Ibid.*, 1965, 18, 204.
3. Capoor, S. P., *Phytopathology*, 1962, 52, 393.
4. Chenulu, V. V., Saibhichandan, J. and Mehta, H. C., *Phytopath. Z.* (In press).
5. Das Gupta, N. N., De, M. L. and Raychaudhuri, S. P., *Nature*, 1961, 168, 115.
6. Raychaudhuri, S. P., Nariani, T. K. and Das, C. R., *Indian Phytopathology*, 1962, 15, 79.



## REVIEWS AND NOTICES OF BOOKS

Organizational Biosynthesis. Edited by Henry J. Vogel, J. Oliver Lampen and Vernon Bryson. (Academic Press, New York and London), 1967. Pp. xx + 549. Price \$19.00.

A symposium on "Organizational Biosynthesis" was held at the Institute of Microbiology of Rutgers, The State University, September 8 to 10, 1966, with support from the National Science Foundation. The meeting took place in conjunction with the Rutgers Bicentennial activities. The proceedings of the symposium are contained in this volume.

The book focuses on the rapidly advancing knowledge of molecular events in the formation of the fundamental biological particles, and on analyses of relevant functional aspects. Experimentalists and theoreticians discuss organizational features of nucleic acid and protein synthesis, as well as juxtaposition phenomena in messenger-ribosome systems and enzyme clusters. The particulate or aggregate structures considered range from the bacterial chromosomes to animal membranes, and from algal and higher-plant chloroplasts to fungal and animal mitochondria. In addition, the assembly ribosomes from substructures is characterized.

The book will be found useful as a source of reference by research workers and others interested in biological structure and function at the definitive molecular level. C. V. R.

The Dinophyceae of the Indian Seas—Part I. Genus *Ceratinum* Schrank. By R. Subrahmanyam. (Marine Biological Association of India—Memoir II), 1968. Pp. iv + 129.

The paucity of information as regards biological, physical and chemical aspects relating to the vast Indian Ocean and its adjacent seas led to the International Indian Ocean Expedition, 1962-65, in which several nations co-operated. Thousands of samples have been collected and it will take a very long time to work them out. The present Memoir on the genus *Ceratinum*, part of the study on the Dinophyceae of the Indian seas, was undertaken long before and its publication now and of the parts to follow, will be of great use to the planktologists working on the Indian Ocean samples. The author has examined material

over several years in the living state and preserved and this has led him to merge many of the *varieties* and *formae* recognized by earlier workers into the *species* as not only are the distinctions employed constant but some are a result of the prolonged action of the preservatives on the cell wall of the organism. Besides the original work of the author, the forms recorded by earlier workers in the Indian Ocean region are also included.

In the first part of the present Memoir, the most important genus, *viz.*, *Ceratinum* of the Class with 78 known species and one new species from the Indian seas are dealt with.

C. V. R.

Reports on Progress in Physics (Vol. XXX, 1967, Part II). Executive Editor A. C. Stickland. (The Institute of Physics and the Physical Society, 47 Belgrave Square, London S.W. 1), 1967. Pp. 375-831. Price £ 2.2 sh.

The review of Part I of this series was published in the March 20, 1968, issue of *Current Science*.

Part II of this series contains the following articles:

Sense-Organs—transducers of the environment, by C. Rashbass; The Solar Wind, by D. B. Beard; Physical contributions to the determination of biological structure and function, by W. Fuller; Recombination emission in inorganic solids, by G. F. J. Garlick; Superconducting magnets, by P. F. Chester; The theory of equilibrium critical phenomena, by M. E. Fisher; and Experimental investigations of critical phenomena, by P. Heller. C. V. R.

Cryogenic Properties of Polymers. Edited by Tito T. Serafini and Jack L. Koenig. (Published by Marcel Dekker, Inc., 95 Madison Avenue, New York, N.Y. 10016), 1968. Pp. 302. Price \$13.75

A Conference on the Properties of Polymers at Cryogenic Temperatures was held at the NASA-Lewis Research Centre and at Case Institute of Technology, Cleveland, Ohio, during April 25, 26 and 27, 1967. The chief objective of this Conference was to provide a critical review of the current status and a discussion of recent progress and problems of polymers

at cryogenic temperatures. All the sixteen papers presented by twenty-eight authors at the Conference are collected in this volume. The subjects cover a wide range from development efforts to fundamental research. The volume will serve as a source book of up-to-date information in this new field of research and development on the behaviour and properties of polymers at very low temperatures. It is sure to stimulate interest to working polymer scientists and materials engineers.

A. S. G.

**Quantum and Statistical Physics.** By M. Alonso and E. J. Finn. (Addison-Wesley Publishing Co. Inc., West End House, 11, Hills Place, London, W. 1), 1968. Pp. 598. Price 67 sh.

This is the third and last volume of a series published under the general title "Fundamental University Physics". The third volume covers most of the subject-matter usually included in an introductory modern physics course. Thus in the first part on Quantum Physics, the treatment includes atoms with one electron, atoms with many electrons, molecules, solids, nuclear structure and nuclear processes, and fundamental particles. The second part on Statistical Physics includes discussions on classical statistical mechanics, thermodynamics, thermal properties of gases, and quantum statistics.

A. S. G.

**Advanced Calculus.** By L. H. Loomis and S. Sternberg. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London, W. 1, England), 1968. Pp. 589. Price 89 sh.

This book is based on an Honours course in advanced calculus that the authors have given over the past seven years. The prerequisites are a good grounding in the calculus of the variable together with some acquaintance with linear algebra. The first half of the book develops the calculus (principally differential), in the setting of normed vector spaces, and the second half deals with the calculus of differentiable manifolds. There are exercises of many different kinds which also include topics not directly dealt with in the text. A. S. G.

#### Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Nuclear Physics to Sri. N. Rana Kumar; Ph.D. degree in Botany to Sri. P. Narasimha Rao.

M.S. University of Baroda has awarded the Ph.D. degree to the following in subjects mentioned against each: Sri. Harmanbhai Bhallaibhai Patel (Physics); Sri. Ramprasad Ambalal Shastri (Chemistry); Sri. Ichhalal Harilal Sheth (Mathematics); Sri. Satya Bhushan Maini (Biochemistry); and Sri. Raojibhai Purushottambhai Patel (Education and Psychology).

Osmania University has awarded the Ph.D. degree in Chemistry to Miss T. Radha Vakula; Ph.D. degree in Zoology to Sri. Sayed Mohd. Ghiasuddin.

#### Indian Association of Biological Sciences

The First Convention of the Indian Association of Biological Sciences will be held in Madras from December 28-30, 1968, under the auspices of the University Grants Commission and the University of Madras.

#### Books Received

**Treatise on Collagen**—(Vol. I): *Chemistry of Collagen*. Edited by G. N. Ramachandran. Pp. xiii + 556. Price 126 sh.; Vol. II: *Biology of Collagen*. Edited by B. S. Govil. Part A: Pp. xvii + 434. Price 110 sh.; Part B: Pp. xv + 488. Price 120 sh.

**Plant Pathologists Pocket Book.** Compiled by Commonwealth Mycological Institute. (Commonwealth Agriculture Bureaux Ferry Lane, Kew, Surrey), 1968. Pp. 267. Price 30 sh.

**Geology of India.** By A. K. Dey. (The Secretary, National Book Trust of India, New Delhi-13), 1968. Pp. x + 178. Price Rs. 5-25.

**The Millipede *Thyropygus* with Special Reference to Indian Species.** By G. Krishnan. (Publications and Information Directorate, C.S.I.R., New Delhi-12), 1968. Pp. 84. Price Rs. 12-00.

**Introduction to Mathematics for College Students.** By K. C. Skeen and C. W. Wheeler. (Addison Wesley Pub. Co., Inc., West End House, 11, Hills Place, London W. 1), 1968. Pp. viii + 424. Price 70 sh.

